February 2020

Structural Systems

Basic Structural Terminology

What is structural design?

- More than crunching numbers.
- Maintaining the balance, between safety, cost and durability.

R101.3 Purpose. The purpose of this code is to establish minimum requirements to safeguard the public safety, health and general welfare through affordability, structural strength, means of egress facilities, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment.

Structural Criteria

- Based on climate and geographical location.
- Includes wind, seismic, flood other environmental hazards such as roof ice dams and termites.

R301.2 Climatic and geographic design criteria. Buildings shall be constructed in accordance with the provisions of this code as limited by the provisions of this section. Additional criteria shall be established by the local *jurisdiction* and set forth in Table R301.2(1).

Construction Systems

- Platform
- Balloon Framing

R301.1.2 Construction systems. The requirements of this code are based on platform and balloon-frame construction for light-frame buildings. The requirements for concrete and masonry buildings are based on a balloon framing system. Other framing systems must have equivalent detailing to ensure force transfer, continuity and compatible deformations.

Platform Framing

[RB] PLATFORM CONSTRUCTION. A method of construction by which floor framing bears on load bearing walls that are not continuous through the *story* levels or floor framing.

- The most common method in modern construction.

Balloon Framing

- Found in historical homes
- Sometimes used in portions of homes for added rigidity (great rooms, stairwells, gable-end walls, etc.)

R602.10.4.8 Balloon frame wall bracing. Balloon frame walls shall have a maximum height of two stories and a maximum length of 20 feet (6096 mm) unless constructed in accordance with an approved design. Wall framing shall be continuous from lowest floor to the wall top plate at the roof. Braced wall panels shall extend to the full-height of the balloon frame wall. All

System Performance

SECTION R301
DESIGN CRITERIA

R301.1 Application. Buildings and structures, and parts thereof, shall be constructed to safely support all loads, including dead loads, live loads, roof loads, flood loads, snow loads, wind loads and seismic loads as prescribed by this code. The construction of buildings and structures in accordance with the provisions of this code shall result in a system that provides a complete load path that meets the requirements for the transfer of loads from their point of origin through the load-resisting elements to the foundation. Buildings and structures constructed as prescribed by this code are deemed to comply with the requirements of this section.

- Structural members do not work independently in light-frame construction. They are always part of a SYSTEM.
- Two basic principles in system performance are:
  - **Load Sharing**
  - **Composite Action**

Load Sharing

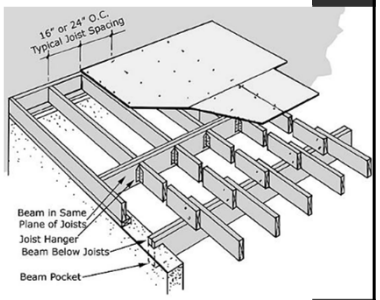
The strength comes from multiple elements sharing the load.

Composite Action

The strength comes from the manner that the elements come together.

(glue, nails, joist spacing, grain direction, staggered joints, etc.)

[RB] STRUCTURAL COMPOSITE LUMBER. Structural members manufactured using wood elements bonded together with exterior adhesives.



Whole House Testing

- **Whole House Testing or Full-House testing** is becoming more popular and a crucial component in the development of many modern building products.
- It shows that the strength comes from the way the building is put together as a SYSTEM.
- Buildings are only as strong as their weakest link.

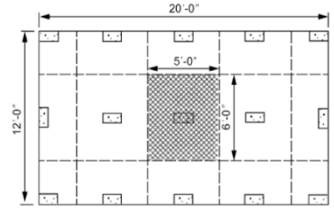
Whole house testing

Earthquake Test
Log Home

Tributary Area

- Is the portion of the load assigned to each member.

AM102.1 Footings. Support posts shall be supported by a minimum footing in accordance with Figure AM102.1(1) and Table AM102.1. Minimum footing depth shall be 12 inches (305 mm) below finished grade in accordance with Section R403.1.4. Tributary area is calculated as shown in Figure AM102.1(2).



For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m².
Note: Tributary area of shaded section on the free standing deck shown is 5' × 6' = 30 square feet (2.79 m²). Code will require a minimum footing of 8" × 16" (203 mm × 406 mm) in accordance with Table AM102.1.

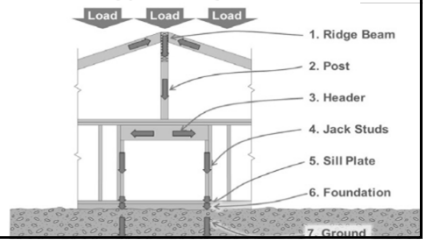
FIGURE AM102.1(2)
CALCULATED TRIBUTARY AREA

Load Path Analysis

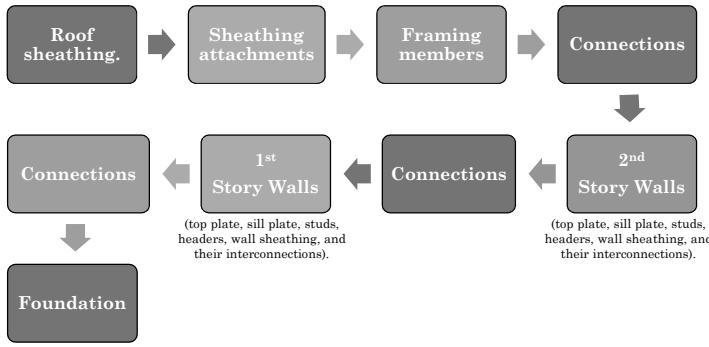
- Used to minimize the material needed in the load-bearing member to support the design load.
- Load paths can be very complex, but the load path must be understood to determine tributary areas.

SECTION R301
DESIGN CRITERIA

R301.1 Application. Buildings and structures, and parts thereof, shall be constructed to safely support all loads, including dead loads, live loads, roof loads, flood loads, snow loads, wind loads and seismic loads as prescribed by this code. The construction of buildings and structures in accordance with the provisions of this code shall result in a system that provides a complete load path that meets the requirements for the transfer of loads from their point of origin through the load-resisting elements to the foundation. Buildings and structures constructed as prescribed by this code are deemed to comply with the requirements of this section.



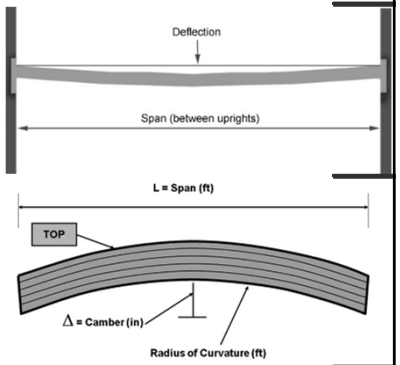
Vertical Load Path Sequence



Deflection

- The code sets limits on the maximum allowable deflection depending on the type of member involved.
- Greater deflection is allowed in ceiling joists and rafters than in floor joists.
- Code Changes: Table R301.7 Deflection also applies to ceilings and exterior walls - wind loads.

R301.7 Deflection. The allowable deflection of any structural member under the live load listed in Sections R301.5 and R301.6 or wind loads determined by Section R301.2.1 shall not exceed the values in Table R301.7.



Deflection

Generally, it is not necessary to calculate the deflection indicated in Table R301.7, since deflection for balloon or platform framing is typically accounted for in the prescriptive design tables of the code.

In other structural systems such as timber framing, deflection calculation is required.

TABLE R301.7
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS[b, c, f]

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes greater than 3:12 with finished ceiling not attached to rafters	*L*/180
Interior walls and partitions	*H*/180
Floors	*L*/360
Ceilings with brittle finishes (including plaster and stucco)	*L*/360
Ceilings with flexible finishes (including gypsum board)	*L*/240
All other structural members	*L*/240
Exterior walls—wind loads[a] with plaster or stucco finish	*H*/360
Exterior walls—wind loads[a] with other brittle finishes	*H*/240
Exterior walls—wind loads[a] with flexible finishes	*H*/120[d]
Lintels supporting masonry veneer walls[e]	*L*/600

Note: *L* = span length, *H* = span height.

a. For the purpose of the determining deflection limits herein, the wind load shall be permitted to be taken as 0.7 times the component and cladding (ASD) loads obtained from Table R301.2(2).

b For cantilever members, *L* shall be taken as twice the length of the cantilever.

c. For aluminum structural members or panels used in roofs or walls of sunroom additions or patio covers, not supporting edge of glass or sandwich panels, the total load deflection shall not exceed *L*/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed *L*/175 for each glass lite or *L*/60 for the entire length of the member, whichever is more stringent. For sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed *L*/120.

d. Deflection for *exterior walls* with interior gypsum board finish shall be limited to an allowable deflection of *H*/180.

e. Refer to Section R703.8.2.

f. When floor spans exceed 20 feet, joists, built-up beams and trusses shall not be spaced greater than 24 inches and deflection shall not exceed *L*/480.

Climatic and Geographic Design Criteria (R301.2)

- Climatic and geographic design criteria is to be determined by the *local jurisdiction* and inserted into Table R301.2(1).
- This information should also be provided to the designer who should list it on the plans submitted for review.

ROOF LOAD (psf)	WIND SPEED (mph)	SEAIMIC DESIGN CATEGORY	SUBJECT TO DAMAGE FROM			WINTER DESIGN TEMP	ICE BARRIER UNDERLAYMENT REQUIRED	FLOOD HAZARD[b]	AIR FREEZING INDEX	MEAN ANNUAL TEMP
			Weathering[a]	Frost Line Depth	Termite[c]					
20	Tables R301.2 (4) & (5)	Table R301.2(7)	Moderate	12"	Moderate-Heavy	Local	Local	Local	Local	Local

a. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code. The grade of masonry units shall be determined from ASTM C34, C55, C62, C73, C90, C129, C145, C216 or C652.
b. The Jurisdiction shall fill in this part of the table with (a) the date of the jurisdiction's entry into the National Flood Insurance Program (date of adoptions of the first code or ordinance for management of flood hazard areas), (b) the date(s) of the currently effective FIRM and FBFM, or other flood hazard map adopted by the community, as may be amended.
c. Protection is required in all of North Carolina per Section R318

Exposure Categories

- Important when applying the provisions for wall sheathing, wood wall bracing, roof uplift resistance, and exterior wall and roof coverings
- Siding, roofing, windows, skylights, exterior doors and overhead doors must be manufactured and installed to resist wind loads based on wind speed and exposure factors. (R301.2.1.4)

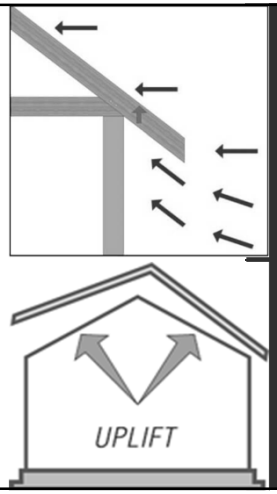
R301.2.1.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the

Wind Exposure B (60-80% buildings)

Wind Exposure C

Uplift

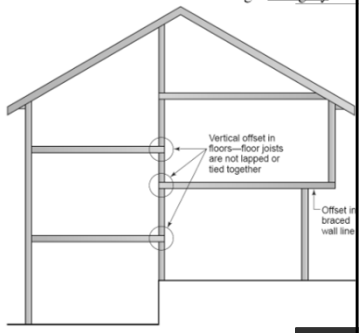
- Upward pressure caused by the ground, wind or surface water, etc.
- Can be resisted by:
  - Dead Loads
  - Mechanical connectors
    (straps, hurricane ties, screws, threaded rods)
  - Sheathing



Irregular Buildings

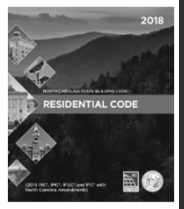
- Buildings with offsets in braced wall lines, arrangement of openings, cantilevers, and/or dissimilar materials in braced wall lines.
- Irregular townhome buildings in SDC C require engineering.
- Mecklenburg is no longer **SDC C**.

R301.2.2.2.5 Irregular buildings. The seismic provisions of this code shall not be used for irregular structures located in Seismic Design Category C.

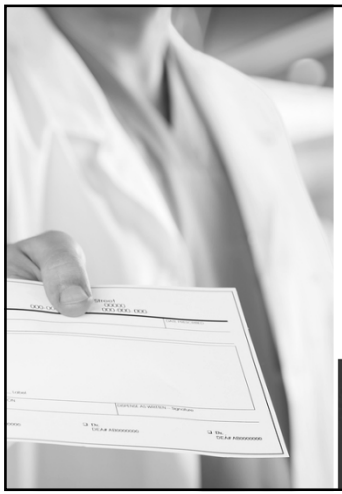


Conventional Design vs. Engineered Design

Conventional Design



- Is prescriptive. Set by the **NCRC**.
- Contains:
  - Span tables
  - Pre-defined details
  - Pre-defined options



Conventional Design - Code Alternatives

- WFCM Wood Frame Construction Manual
- AISI S230 (Cold Formed Steel)
- ICC 400 (Log Homes)
- AAMA/NPEA/NSA 2100. (Sunrooms) ***Code Change**

Conventional Design

- **Most used method in single family homes.**
  90% of our residential projects are single family homes.
- **Easy for builders & inspectors**
  NO Registered Design Professional required.

R301.1.3 Engineered design. Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for buildings and structures, and parts thereof, included in the scope of this code.

Engineered Design

- The design is not constrained to fit within the limitations of prescriptive design.
- Conventional details can still be used where they are applicable.
- Engineers can design specific design components while using prescriptive requirements for the rest of the building.

Engineered design is typically required when using:

- Long spans
- High Hazards (wind, flood, seismic)
- Unconventional Products
- Bad soils
- High end features

(atriums, high-tech appliances, etc.

- Foundation walls exceeding 48" unbalanced fill with no lateral support at the bottom or hydrostatic pressure. (code change)
- Exceeding max. story height.
  - Wood frame & SIP 11'-7"
  - Masonry 13'-7".

In any case…

The Design Team **MUST** know and follow:

- Code requirements
- Amendments
- Referenced standards
- Local Interpretations

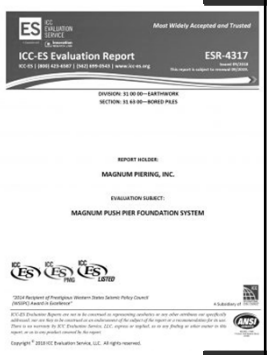
Alternative Provisions (R301.1.1- R301.1.3)

- AF&PA Wood Frame Construction Manual (WFCM).
- AISI Standard for Cold-formed Steel Framing—Prescriptive Method for One-and Two-Family Dwellings (AISI S230).
- ICC-400 Standard on the Design and Construction of Log Structures.
- AAMA/NPEA/NSA 2100 for sunrooms.
- Accepted engineering practice
- Engineered design in accordance with the IBC.

Accepted engineering practice

May include:

- A design prepared by a licensed professional engineer or architect.
- Evaluation reports from the ICC Evaluation Services® - ICC ES®.
- Manufacturer's information containing test results or case studies.
- Other materials within the judgment of the building official.


ICC-ES Evaluation Report

ESR-4317

DIVISION: 31 00 00—EARTHWORK
SECTION: 31 62 00—BORED PILES

REPORT HOLDER:

MAGNUM PIERING, INC.

EVALUATION SUBJECT:

MAGNUM PUSH PIER FOUNDATION SYSTEM

Other Referenced Standards:

- **Wood Frame Construction Manual** (AWC) (R301.1.1)
- **NDS -***National Design Specifications for Wood Construction* (AWC)
- **ACI-318** - *Building Code Requirements for Structural Concrete* (ACI)
- **ACI-530** - *Building Code Requirements for Masonry Structures* (ACI)
- **ASCE 7-10** - *Minimum Design Loads for Buildings and Other Structures.*

When reviewing structural drawings…

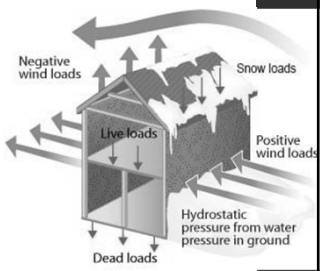
- Make sure they show 100% complete construction documents.
- Remember that structural notes take precedence over specifications. (exception to the norm).
- Plans should always have dimensions.

Design Loads

Design Loads

Are the maximum amount of force the structural system is designed to resist.

- Vertical Loads
- Horizontal Loads

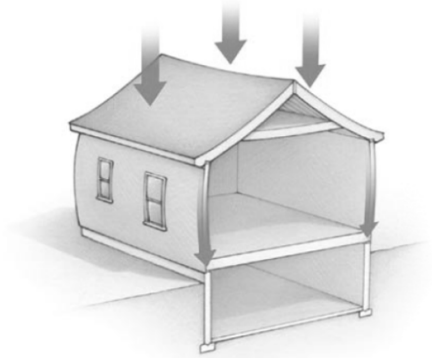


Vertical Loads

- Dead
- Live
- Snow
- Wind uplift
- Seismic and wind (overturning)
- Seismic (vertical ground motion)

Horizontal loads

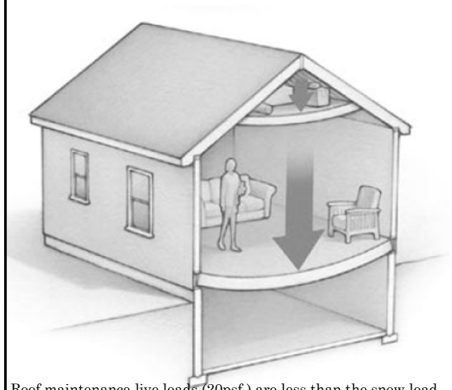
- Wind
- Seismic
- Flood (static and dynamic hydraulic forces)
- Soil (active lateral pressure)



Weight of all permanent components and fixed equipment

Dead Loads

(R301.4)



Roof maintenance live loads (20psf.) are less than the snow load.

Live Loads

(R301.5)

Table R301.5

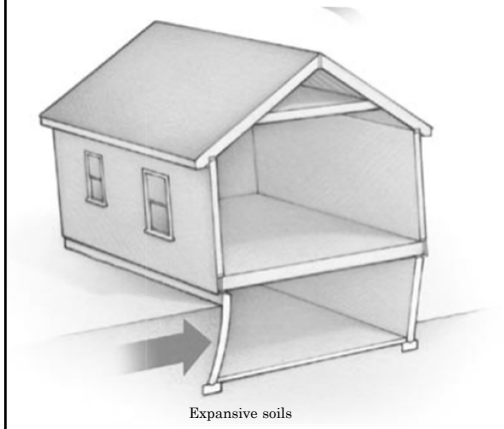
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

(IN POUNDS PER SQUARE FOOT)

USE	LIVE LOAD
Uninhabitable attics without storage [b]	10
Uninhabitable attics with limited storage [b, g]	20
Habitable attics and attics served with fixed stairs	30
Balconies (exterior) and decks [e]	40
Fire Escapes	40
Guards and handrails [d]	200 [h]
Guard in-fill components [f]	50 [h]
Passenger vehicle garages [a]	50 [a]
Rooms other than sleeping rooms	40
Sleeping rooms	30
Stairs	40 [c]

Live Loads

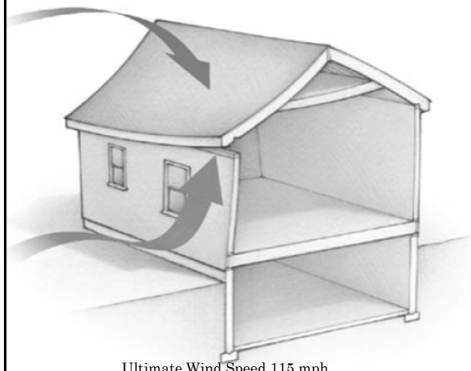
(R301.5)



Expansive soils

Soil Lateral Loads

(Table R405.1)



Ultimate Wind Speed 115 mph.

Wind Loads

Table R301.2(2)

"The larger the sail area, the more bracing is required".

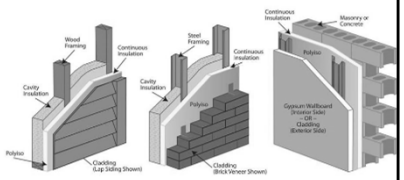
Ultimate Wind Speed (Code Change 301.2.1.3)

- Wind speed terminology has changed, but the requirements are the same.
  - Basic Wind Speed was **90 mph**
  - Ultimate Wind Speed is **115 mph**
- Ultimate Wind Speed was introduced because most standards are facing out Allowable Stress Design in favor of Load Resistance Factored Design
- Basic speed numbers are still necessary to evaluate many product.

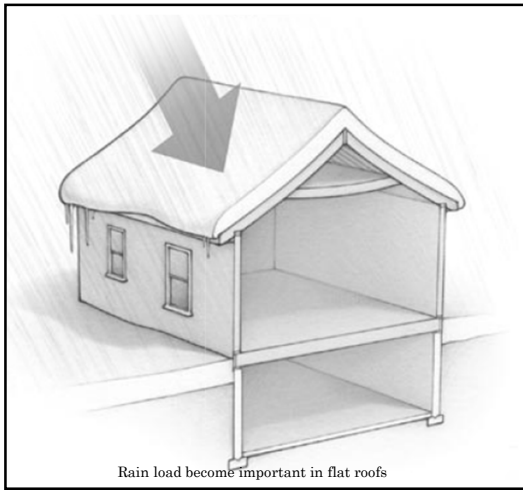
Basic = ASD (Allowable Stress Design)
Ultimate = LRFD (Load Resistance Factored Design)

Wind Resistance (Code Change R316.8)

- Where foam plastic insulation is used as *exterior wall* sheathing on framed wall assemblies, it shall comply with Section R316.8.
- ASTM C578 & C1289
- SBCA FS100.

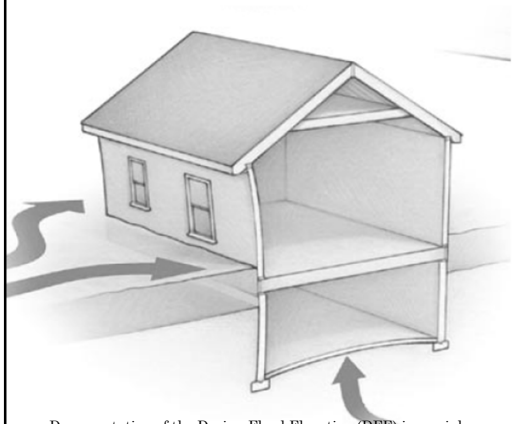


Continuous Insulation Sheathing



Rain load become important in flat roofs

Snow & Rain Loads



Documentation of the Design Flood Elevation (DFE) is crucial.

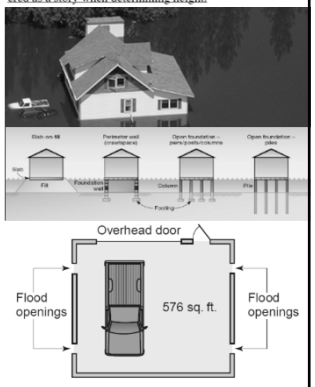
Flood Loads

Flood Resistant Construction

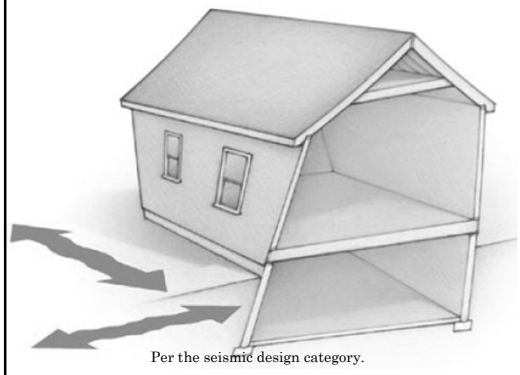
(Code Change) R322

- ASCE 24 may now be used as an alternate.
- It requires structures to be elevated above the Flood Insurance Rate Map (FIRM) elevation.
- Allows parking, building access & storage is allowed below the F.E. if it has flood openings per R322.2.2.1. (Doors and windows don't count).

[RB] STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above. A flood-resistant enclosure, designed to break away so as not to cause collapse, shall not be considered as a story when determining height.



Garage below design flood elevation used for parking and storage only



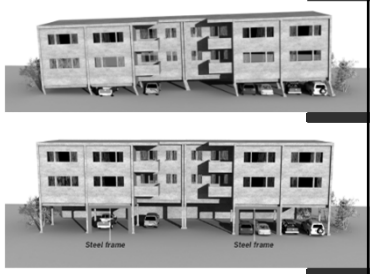
Per the seismic design category.

Seismic Loads

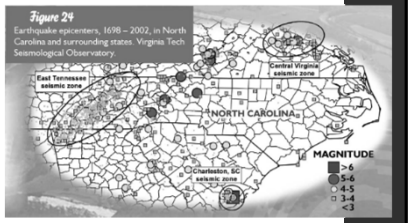
Table R301.2(7)

Seismic Failures

- A soft-story building is a multi-level structure located over a ground level with large openings, typically parking.
- During an earthquake the heavier to puts disproportionate stress on the carport causing collapse.
- Buildings may be retrofitted with steel frames, reinforced walls or braces drilled into the foundation.



Seismic Activity in NC



- North Carolina has its share of earthquakes, but large, damaging seismic events are rare.
- Most minor earthquakes (< 3.0) occur unnoticed and are a normal process that allows the earth to ease built-up geological strain
- Although strong earthquakes here in North Carolina are rare, proper construction techniques needs to be followed as required by code. An earthquake of magnitude 5.0 or greater could cause major damage.

Seismic Design Category

(Code Change)

- Mecklenburg County was dropped from Category C to B.
- Therefore, anchorage not required for townhomes for:
  - Interior nonstructural walls and partitions
  - Cantilevered elements
  - Parapets
  - Curtain wall and precast cladding
  - Suspended Ceilings
  - Cabinets
  - MEP Attachments

Standard Responsibilities for Structural Code Compliance

Contractor

Compliance for items not visible to the inspector, are the Contractor's Responsibility.

Registered Design Professional

- On plans that are designed & sealed by an architect or engineer: MCCE will not perform specific calculations, such as confirming that the proper amounts of wall bracing are provided.
- This is the RDPs responsibility.

Inspector

- If non compliant items, such minimum bracing amounts as are found on the field, the condition shall be corrected by the Field Inspector as required by code.
- An N.O.V. may be issued.

Plan Reviewer

- Plan Reviewers shall require engineers to specify all information necessary to execute the project, such as:
  - the bracing method.
  - locations of braced wall lines & panels.
  - the method of attachment for braced wall panels.

February 2020

Wall Bracing

A GUIDE TO THE 2015 IRC® Wood Wall Bracing Provisions

This presentation is partially based on *A Guide to the 2015 IRC Wood Wall Bracing Provisions*, with NC amendments.

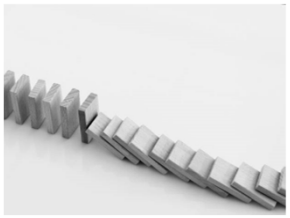
Why is it important to understand it?

The better the code is understood, the more likely it is to be correctly applied.

The more you know, the easier your job is.

Wall Bracing
(R602.10)

- Since the exterior walls of a structure are typically made up of repetitive vertical studs, wall bracing is required to give it strength against wind or earthquake forces.
- The bracing, resists forces that may cause the structure to "rack," twist or shift.



Bracing is simple, Right???

- APA & ICC wrote a 324 page book explaining the braced-wall requirements called:

"*A Guide to the 2015 IRC Wood Wall Bracing Provisions.*"

So… no, it is not that simple.

History of wall bracing

- Wall bracing requirements are not new to the codes.
- In fact, several of the current bracing methods, including let-in bracing, diagonal wood boards and Portland cement plaster, reflect conventional construction practices that were common over 50 years ago.

Development of wall bracing 2000

The 2000 IRC introduced several new bracing provisions and methods:

- Minimum bracing percentage
- Maximum braced wall line spacing
- Continuous sheathing
- Portal frames
- Separate bracing requirements for wind and seismic

Development of wall bracing 2012

- The 2012 IRC reworded the bracing section to make it more understandable and consistent.
- The 2012 IRC added the Simplified Method and 2012 NCRC incorporated it as an amendment.

Development of wall bracing - 2015

- The 2015 IRC added a few additional tweaks to wall bracing due to changes in proprietary hold-down straps.
- The 2015 IRC also expands the use of Simplified Wall Bracing provisions
- The 2018 NCRC remained the same.

Why are code updates important?

- We don't build like we used to.
- We now see larger homes, larger openings and new materials.

New Design Trends
(1960-2020)

- Open concepts
- High ceilings.
- Two-story great rooms and foyers.
- Natural light, more windows.

Ranch style houses
1500 sqft.
(1960s)

Bi and Tri level houses
2500 sqft.
(1970-1990s)

Mega-mansions
9000 sqft.
(2000s)

Townhomes
9000 sqft.
(2010s)

Wall Attachment Failures

Damage likely initiated from the failure of garage doors. Subsequent pressurization of the garage portion of the home and insufficient attachment caused the gable end wall and rear of the garage to be pushed out. As a result, these portions of the wall could no longer provide bracing or vertical support for the rest of the structure. (Photo taken after a tornado in Fayetteville, North Carolina.)

This figure shows insufficient attachment of the end walls of the structure. It also shows failures in the wall covering products used to weatherproof the structure, as well as failure of the connection of the braced wall panel to the structure (at the far end of the wall). (Photo taken after a tornado in Evansville, Indiana.)

This building failed due to insufficient attachment of numerous structural elements, including receiving wall-to-roof, roof-to-wall, and wall-to-wall. The entire roof of this structure was lifted off in one piece and struck the house across the street. (Photo taken after Hurricane Iniki.)

Racking Failures

(File photos, both wind and seismic events.)

Connection failure

Insufficient (or non-existent) anchorage of the walls to the foundation caused the entire structure to slide approximately 6 feet off the foundation. (Photo taken after a tornado in Fayetteville, North Carolina.)

A closer look at the foundation shows negligible connection of the sill plate to the foundation. The framer attempted to use nails to make this connection; however the nails are mostly bent at the tip and did not significantly penetrate the masonry foundation walls. (Photo taken after a tornado in Fayetteville, North Carolina.)

Important Terminology

Definitions

[RB] BRACED WALL CONTINUOUSLY SHEATHED. A *braced wall* with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

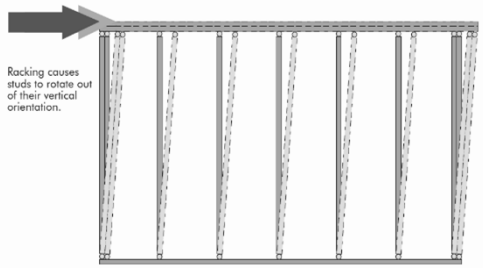
[RB] SHEAR WALL. A general term for walls that are designed and constructed to resist racking from seismic and wind by use of masonry, concrete, cold-formed steel or wood framing in accordance with Chapter 6 of this code and the associated limitations in Section R301.2 of this code.

[RB] BRACED WALL PANEL. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors. The panel's length meets the requirements of its particular bracing method, and contributes toward the total amount of bracing required along its *braced wall line* in accordance with Section R602.10.1.

Put simply, the term "braced wall panel" describes a code-qualified bracing element. The origin of the name "panel" most likely lies in the fact that most of the recognized methods of bracing use panel-type products; however, the term is somewhat of a misnomer. "Panel" can actually be used to describe a wall "section," "segment," or "unit." Even let-in bracing is often referred to as a bracing panel. As such, the terms braced wall panel, braced wall section, braced wall segment and bracing unit are often used interchangeably.

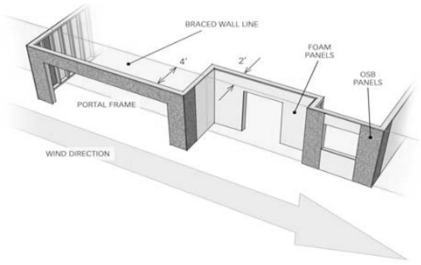
Racking

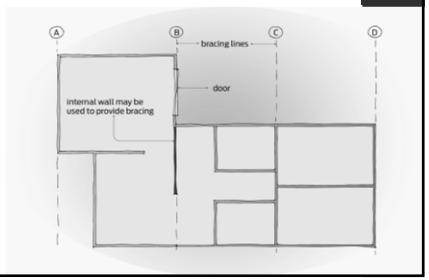
- Wall bracing is meant to resists racking.
- As little as 3/8" of racking can make doors stick.



Braced Wall Line

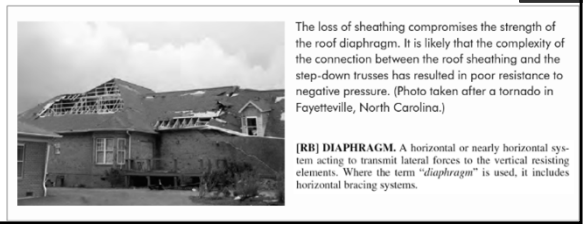
An imaginary straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.





Diaphragm

- A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical resisting elements.
- When the term "diaphragm" is used, it refers to horizontal bracing systems. e.g. floor or roof.



The loss of sheathing compromises the strength of the roof diaphragm. It is likely that the complexity of the connection between the roof sheathing and the step-down trusses has resulted in poor resistance to negative pressure. (Photo taken after a tornado in Fayetteville, North Carolina.)

[RB] DIAPHRAGM. A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical resisting elements. Where the term "*diaphragm*" is used, it includes horizontal bracing systems.

Continuity

R602.10.3 Continuous sheathing.

4. Exterior walls shall be sheathed on all sheathable surfaces including infill areas between braced wall panels, above and below wall openings, and on gable end walls.

- Continuous wall bracing must extend up the gable end walls if present.
- This ensures that the load path is continuous from the foundation to the roof diaphragm.

What is the difference between a Shear Wall and a Braced Wall?

Shear Wall
is engineered.

- Wood structural panels
- May have pre-engineered hold downs in addition to anchor bolts.
- Designed per:
  IBC ⇨ ASCE-7 ⇨ SDPWS

Braced wall
is prescriptive.

- Per the IRC
- Braced Wall Panels
- Anchor bolts.

Horizontal Loads can be resisted by:

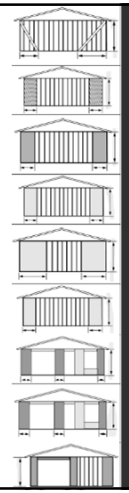
- Braced wall panels
- Engineered shear walls
- Portal frames

Shear Wall

- This is a general term used for walls that are designed and constructed to resist racking from seismic and wind by use of masonry, concrete, cold-formed steel or wood framing.
- They are designed in accordance with Chapter 6 of the code and the associated limitations in Section R301.2 of the code (seismic).

Braced Wall Panel

- A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors.



Reviewing Bracing Methods

Step 1 : Identify the bracing method used

R602.10

1. Isolated panel bracing (R602.10.2)
2. Continuous sheathing (R602.10.3)
3. Engineered design (R602.10.5)
4. 2015 IRC, Section R602.10
5. SR-102 as published by APA

Portions of the system (R602.10)

Portions of the building that can not comply with the IRC may be engineered. t.

Where a building, or portion thereof, does not comply with Section R602.10.2, R602.10.3, or R602.10.4, those portions shall be designed and constructed in accordance with Section R602.10.5.

R602.10.5 Wall bracing by engineered design. Design using bracing materials and methods listed in Table R602.10.1 or approved alternative materials and methods shall be permitted and shall comply with accepted engineering practice. Accepted engineering practice shall include the following:

1. Design in accordance with Section R301.
2. Design equivalent to the analysis basis of the provisions in Sections R602.10.2, R602.10.3, and R602.10.4, including determination of design loads, design unit shear values, and bracing amounts.

Bracing Methods

- Very good but limited to small homes with limited openings.
- Requires craftsmanship

- ½ the capacity of the others

- 2 continuous methods.
- CS-WSP provides the greatest capacity

TABLE R602.10.1
BRACING METHODS[a,b]

METHOD	MINIMUM BRACE MATERIAL THICKNESS OR SIZE	MINIMUM BRACE PANEL LENGTH OR BRACE ANGLE	CONNECTION CRITERIA		FIGURE OF BRACING METHOD. NOT NECESSARILY LOCATION
			Fasteners	Spacing	
LIB Let-in-bracing	1 × 4 wood brace (or approved metal brace installed per manufacturer instructions)	45° angle for maximum 16" o.c. stud spacing[d]	2-8d common nails or 3-8d (2½" long × 0.113" dia.) nails	Per stud and top and bottom plates	
DWB Diagonal wood boards	¾" (1" nominal)	48"	2-8d (2½" long × 0.113" diameter) or 2 - 1½" long staples	Per stud and top and bottom plates	
WSP Wood structural panel	⅜"	48"[d]	6d common nail or 8d (2⅜" long × 0.113" diameter) nail [See Table R602.3(3)]	6" edges 12" field	
SFB Structural fiberboard sheathing	½"	48"[d]	1½" long × 0.120" diameter galvanized roofing nails	3" edges 6" field	
GB Gypsum board installed on both sides of wall	½"	96" for use with R602.10.2 48" for use with R602.10.3	Minimum 5d cooler nails or #6 screws	7" edges 7" field	
PCP Portland cement plaster	⅞" (maximum 16" o.c. stud spacing)	48"	1½" long, 11 gage, ⅞" diameter head nails or ⅞" long,	6" o.c. on all framing members	
CS-WSP[c,i] Continuously sheathed WSP	⅜"	24" adjacent to window not more than 67% of wall height; 30" adjacent to door or window greater than 67% and less than 85% of wall height. 48" for taller openings.	Same as WSP	Same as WSP	
CS-SFB[c,i] Continuously sheathed SFB	½"		Same as SFB	Same as SFB	
PF Portal Frame[f,g,h]	⅜"	See Figure R602.10.1	See Figure R602.10.1	See Figure R602.10.1	

Notes

Notes:

a. Alternative bracing materials and methods shall comply with Section 105 of the *North Carolina Administrative Code and Policies*, and shall be permitted to be used as a substitute for any of the bracing materials listed in Table R602.10.1 provided at least equivalent performance is demonstrated. Where the tested bracing strength or stiffness differs from tabulated materials, the bracing amount required for the alternative material shall be permitted to be factored to achieve equivalence.

b. All edges of panel-type wall bracing required from Tables R602.10.1 and R602.10.3 shall be attached to framing or blocking, except GB bracing horizontal joints shall not be required to be blocked when joints are finished.

c. Two LIB braces installed at a 60° angle shall be permitted to be substituted for each 45° angle LIB brace.

d. For 8-foot (2483 mm) or 9-foot (2743 mm) wall height, brace panel minimum length shall be permitted to be reduced to 36-inch (914 mm) or 42-inch length (1067 mm), respectively, where not located adjacent to a door opening. A braced wall panel shall be permitted to be reduced to a 32-inch (813 mm) length when studs at each end of the braced wall panel are anchored to foundation or framing below using hold-down device with minimum 2,800 pounds design tension capacity. For detached single story garages and attached garages supporting roof only, a minimum 24-inch (610 mm) brace panel length shall be permitted on one wall containing one or more garage door openings.

e. Bracing methods designated CS-WSP and CS-SFB shall have sheathing installed on all sheathable surfaces above, below, and between wall openings.

f. For purposes of bracing in accordance with Section R602.10.2, two portal frame brace panels with wood structural panel sheathing applied to the exterior face of each brace panel as shown in Figure R602.10.1 shall be considered equivalent to one braced wall panel.

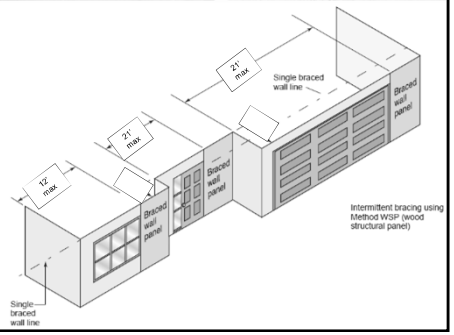
g. Structural fiberboard (SFB) shall not be used in portal frame construction.

h. No more than three portal frames shall be used in a single building elevation.

i. CS-WSP and CS-SFB cannot be mixed on the same story. Gable ends shall match the panel type of the wall below.

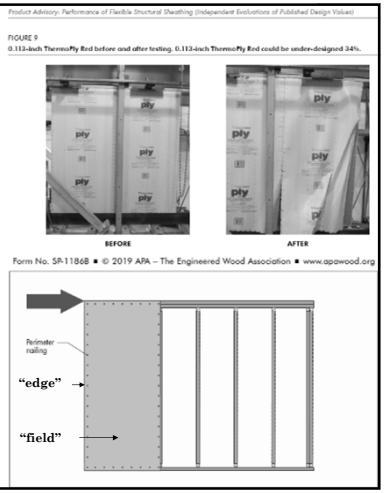
Isolated

- Used in separate locations along a braced wall line.
- Nonstructural sheathing can be used in areas of the wall where bracing is not required. (no blocking required)



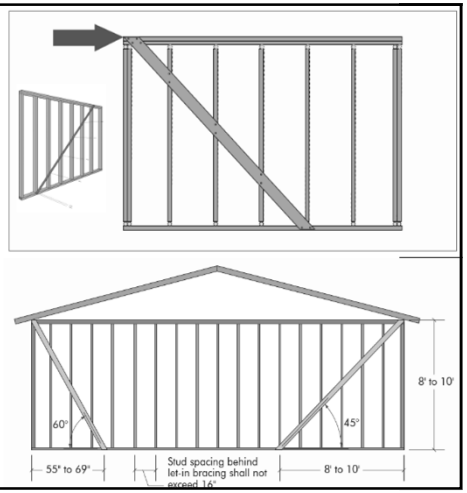
Nailing

- Edge nailing can be 3”-7” depending on the method. It’s job is to resist racking.
- Field nailing can be 6-12” depending on the method. It’s job is to resist buckling.



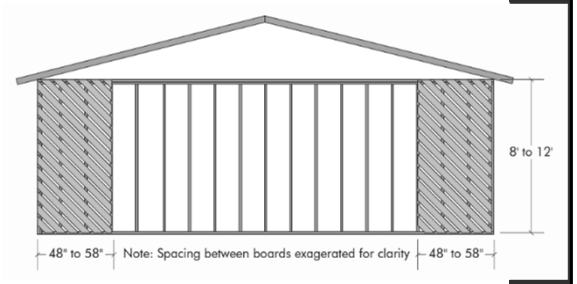
LIB

- The effectiveness of let-in bracing depends on the craftsmanship of the framer when cutting the notches for the 1x4 brace.
- There are some metal alternate products available (ESR required).
- Both have limited structural capabilities, works very well in small homes.



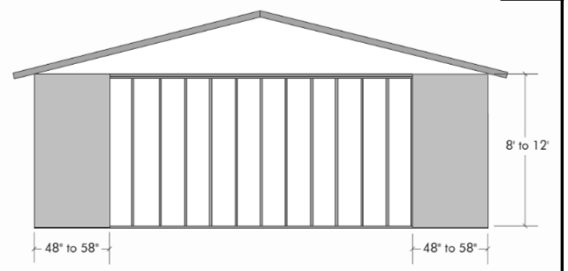
DWB

- Diagonal Wood Bracing



WSP

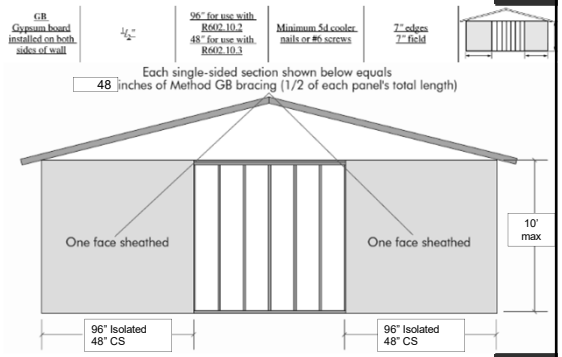
- Wood Structural Panel
- The greatest bracing capacity.



GB

- 7" Edges & Field nailing (regardless of fastener type).
- 1/2 as strong as CS-WSP . This is method with the lowest capacity.

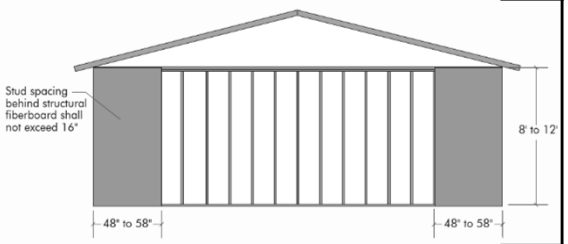
6. Except when used for bracing method GB, the interior side of exterior walls and both sides of interior walls shall be sheathed continuously with minimum $^1/_2$-inch (12.7 mm) thick gypsum wall board interior finish fastened in accordance with Table R702.3.5, or approved interior finish of equivalent or greater shear resistance.



d. For 8-foot (2483 mm) or 9-foot (2743 mm) wall height, brace panel minimum length shall be permitted to be reduced to 36-inch (914 mm) or 42-inch length (1067 mm), respectively, where not located adjacent to a door opening. A braced wall panel shall be permitted to be reduced to a 32-inch (813 mm) length when studs at each end of the braced wall panel are anchored to foundation or framing below using hold-down device with minimum 2,800 pounds design tension capacity. For detached single story garages and attached garages supporting roof only, a minimum 24-inch (610 mm) brace panel length shall be permitted on one wall containing one or more garage door openings.

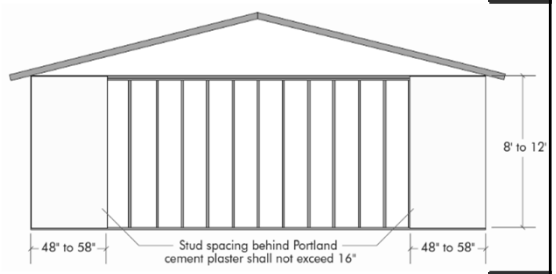
SFB

- Method SFB (structural fiberboard sheathing)



PCP

- Portland cement plaster



PF (top defects)

- It is important to include the door transom in the calculation!
- A door is not the same as a window when doing the wall/height ratio calculation.
- Not providing reinforcement on stem walls ≤48". (other methods too)

Continuous

- The whole wall line is sheathed, including above and below openings and at gable ends .
- The whole wall line is blocked at horizontal joints.
- Requires less bracing and permits the use of narrower bracing panels

CS-WSP

- Provides the greatest bracing capacity
- All sheathable surfaces of the exterior walls are required to have sheathing, even if the design calls for an interior braced wall line & panels.
- CS-WSP panels next to openings shall use the largest opening on either side of a panel to determine min panel size per Table R602.10.1;
- Include transoms in the opening height if present.

CS-SFB

- Continuously sheathed structural fiberboard.
- Other bracing methods may not be used in a Method CS-SFB wall line.

Blocking (Per MCCE)

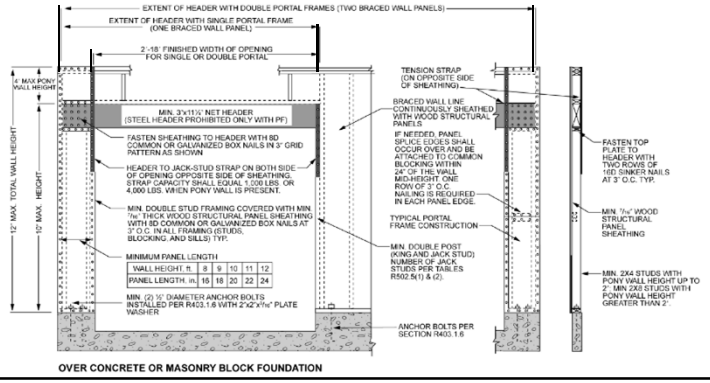
- Isolated Panel Bracing:

Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.

- Continuous sheathing methods (CS): Every panel is a braced wall panel and shall be blocked.

Portal Frames

Portal Frame

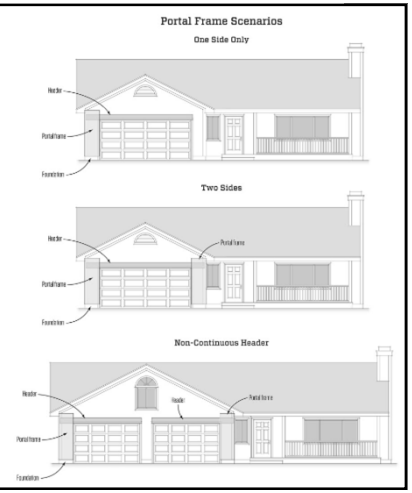


Portal Frames

- With a few small openings, providing bracing it is easy.
- Large openings such as garage doors, can complicate the design.
- This is where portal frames come into play.

Portal Frame Garage

- In a portal frame, the header extends past the opening and is tied to its wall with overlapping plywood or OSB to stiffen the joint.
- (R602.10, R602.12)



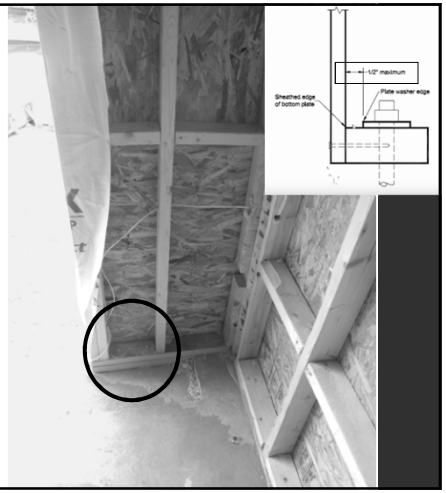
3. Common defects

- **Panel Joints are critical**
- Making a panel joint near to the bottom of the supporting wall weakens the wall's resistance to shear. (See
- Breaking the structural panel joint below the header reduces resistance to rotation.

3. Common defects

- Each portal frame needs two anchor bolts, and they should be as close to the edges of the wall panel **as it's practical to place them** (not both on one side, as seen in photo above).
- The anchor bolts should have square plate washers and nuts.

tests



3. Common defects

- **Nailing details** are important.
- Heavy nailing is a critical to keep the corner joint stiff and prevent racking. (more nails than required will split the wood)
- A 1,200 SF. house may need up to 10,000 nails

ANCHORAGE

Foundation anchorage
R403.1.6

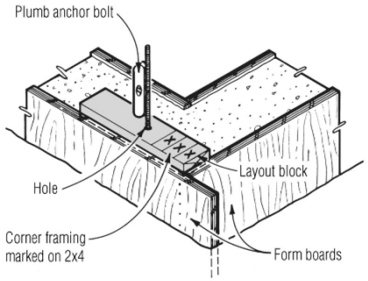
- The wood sill plate must be anchored to the foundation with anchor bolts spaced a maximum of 6 feet on center.

Foundation anchorage
R403.1.6

- There must be a minimum of two bolts per sill plate section.
- 6 Ft. O.C. and 12" at the corners.

Foundation anchorage
R403.1.6

- There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches or less from each end of the plate section.

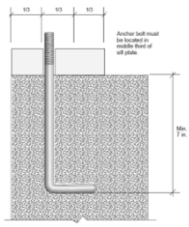


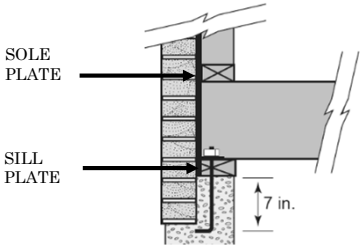
Foundation anchorage
R403.1.6

- Bolts should be at least 1/2 inch in diameter and should extend a minimum of 7 inches into the concrete or masonry foundation.
- A nut and washer is required on each bolt to hold the plate to the foundation.

Foundation anchorage
R403.1.6

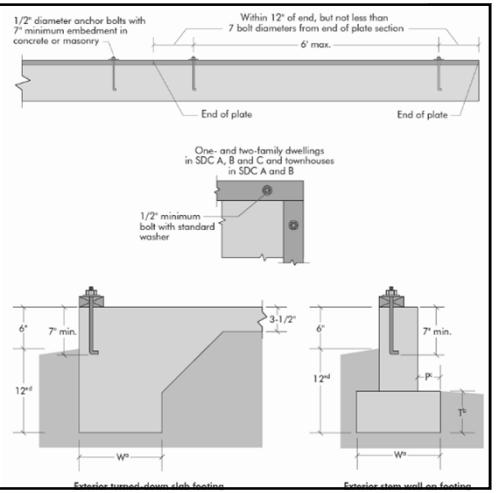
- Anchor Placement





Foundation requirements for continuous footings

(turned-down slab edge, thickened slab, masonry or concrete foundation wall)

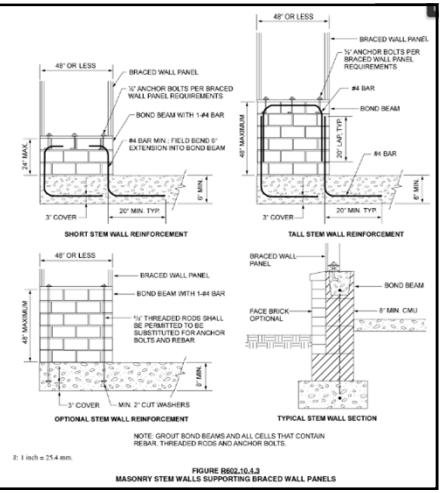


Foundation anchorage
R403.1.6

- Masonry stem walls 48” or less in length that support any braced wall panels (BWP) shall be reinforced per R602.10.5.3
- This includes stem walls supporting any BWPs including the portal frame (PF) bracing method.

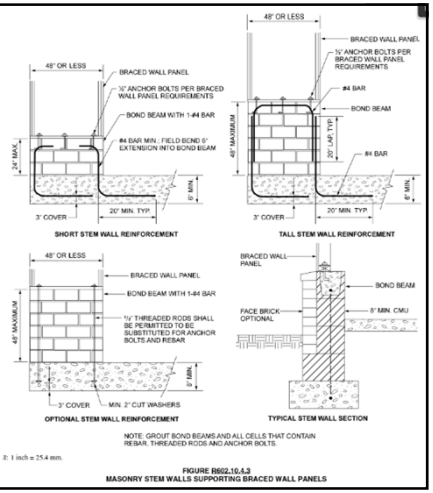
Stem Walls

- The reinforcement details in Figure R602.10.4.3 are appropriate for masonry stem walls that are up to 4 feet in length and not more than 4 feet in height.



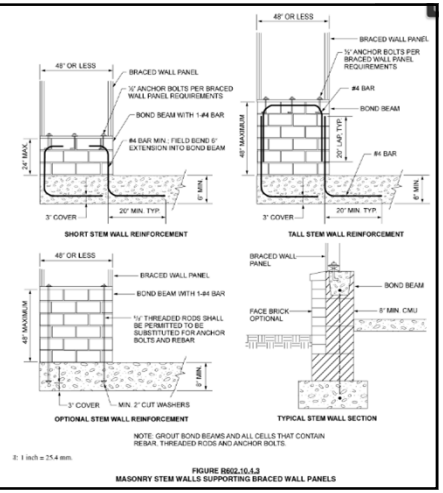
Stem Walls

- If the masonry stem walls are taller than 4 feet, an engineered design of the reinforcement is required.



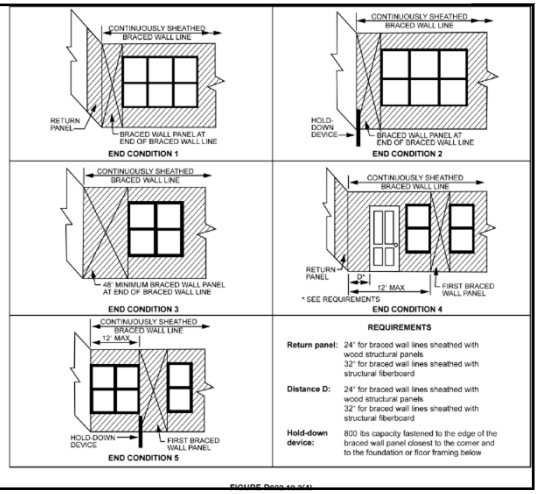
Stem Walls

- If the masonry stem walls are longer than 4 feet, this specific reinforcement is not necessary (standard construction in accordance with section R403.1.3.2 is sufficient).



End Conditions

- The code offers five, end conditions which are intended to provide equivalent hold-down strength as is required in the IBC.
- They only apply to continuous sheathing.



Roof Connections

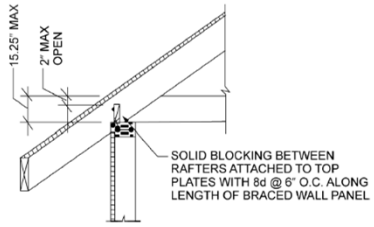


FIGURE R602.10.4.5(1)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES

Potential structural problems with roof ventilation and/or if no protective finish is provided.

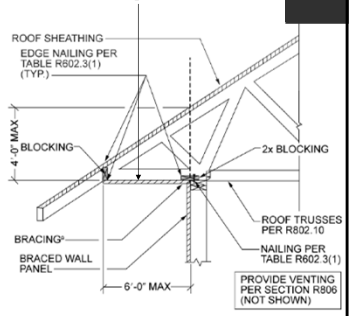


FIGURE R602.10.4.5(2)
ALTERNATE TO FIGURE R602.10.4.5(1) OR FIGURE R602.10.4.5(3)

2018 NORTH CAROLINA RESIDENTIAL CODE

Roof Connections

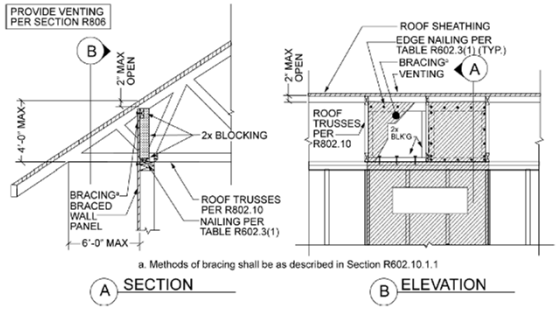


FIGURE R602.10.4.5(3)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS OR TRUSSES

March 2020

Fire Safety

Fire Safety

- Most US fires occur in residential buildings, particularly one- and two-family dwellings.
- These fires account for more than 80% of all deaths from fire in residential uses (including hotels, apartments, dormitories, etc.) and about two-thirds of all fire fatalities in any type of building.
- One- and two-family dwellings also account for more than 80% of residential property losses and more than one-half of all property losses from fire.

Fire Safety

Primary:
Alert and Evacuate

Secondary:
Property Damage

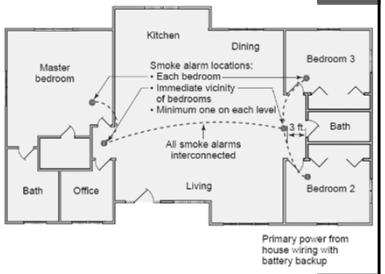
Basic Fire Safety provisions

- Smoke alarms
- Egress
- Fire Separation Distance (FSD)

Smoke alarms

Where are smoke alarms required?

- Each sleeping room.
- Right outside the sleeping rooms.
- Basements and habitable attics

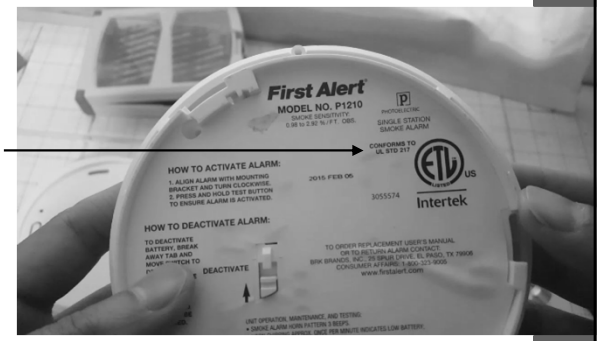


Smoke Alarms (R314.6) Power

- Primary power from house wiring with battery backup.

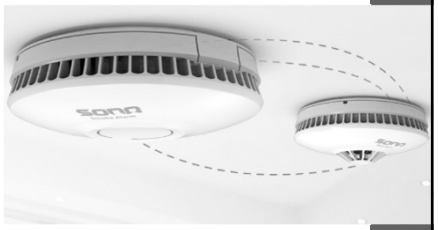
Smoke Alarms (R314.1.1) Listing

- UL 217



Smoke Alarms (R314.4) Interconnection

- Must be interconnected
- Interconnectivity may be wired or wireless.



Smoke Alarms Required (R314.2.2)

Major Renovations & interior additions:

- Permanent wiring is required.

Smoke Alarms Required (R314.2.2)

Minor Building Renovations:

- A smoke alarm is required. Battery power may be provided.
- Plumbing or mechanical work in existing dwellings also does not trigger the smoke alarm requirements.

Fire Alarms (R314.7)

- Fire alarm systems shall be permitted to be used in lieu of smoke alarms.
- Fire alarms are most often seen in combination with home security systems.

Residential Sprinklers

- Not required by the NCRC.
- Optional: Regulated by NFPA 13D or P2904.

Residential Sprinklers Differences

13D	13R
• Quickest response. • Primarily for life safety (not property protection) • Partial coverage. (not attics, closets, bathrooms, garages, concealed spaces, etc.) • No mixed use.	• Quick-response. • Primarily for life safety (not property protection) • Partial coverage. (not attics, closets, bathrooms, garages, concealed spaces, etc.) • No mixed use.
• One- and two-family dwellings and townhouses. • Maximum three stories + attic.	• Apartments, hotels, motels, dormitories & 4 story townhomes. • Maximum four stories.
• Water supply duration. (10min). • Domestic water supply, a water well, an elevated storage tank, or approved tank allowed (or any combination). • No backflow device.	• Water supply duration. (30 min) • Approved water pressure & Backflow device.
• PEX and CPVC pipe allowed.	• CPVC and metallic pipe allowed.

Section R302 – Fire Resistant Construction

Fire Separation Distance (FSD)

See Ch.2 Definition

- Limits the spread of fire to protect property and occupants
- Provides time for fire-fighting.

Exterior wall protection (R302.1)

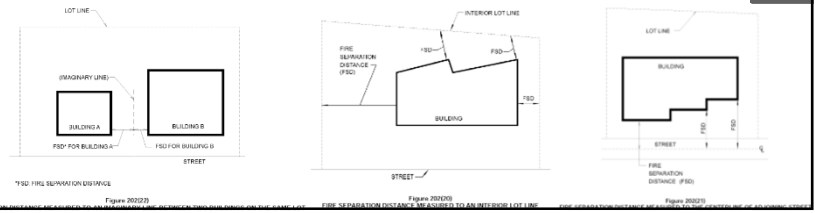
- Exterior walls or projections:

  < 3 ft. = 1 hr. req.

- Windows or doors:

  .

  < 3 ft. = not permitted



Accessory Dwelling Units and Temporary Health Care Structures

- Building Code requirements are completely different from zoning requirements.

Basic building requirements for Accessory Dwelling Units and Temporary Health Care Structures:

ADU

- Attached ADU: This setup is similar to a duplex with no connectivity between units. 1 hr. fire separation is required and a separate address shall be required.
- Detached ADU: Is considered a second building in the same lot. A 3'-0" min. fire separation distance is required.
- Connected ADU: An ADU directly connected to the main structure (door or stair) is considered an extension of the primary residence and no fire separation is required.

Temporary health care structures

- The unit must be assembled off-site and built to the standards of the State Building Code for Manufactured Homes. It must be no more than 300 gross square feet. It can NOT be placed on a permanent foundation.

Basic <u>zoning requirements</u> for Accessory Dwelling Units and Temporary Health Care Structures.

- **ADU**

A second dwelling unit located within the principal detached dwelling or within a separate accessory structure. The unit must include both kitchen and bathroom facilities and be intended for use as a year-round residence. Other restrictions apply when located in a mixed-use development, within a principal single family home, or within an accessory structure.

- **Temporary health care structures**

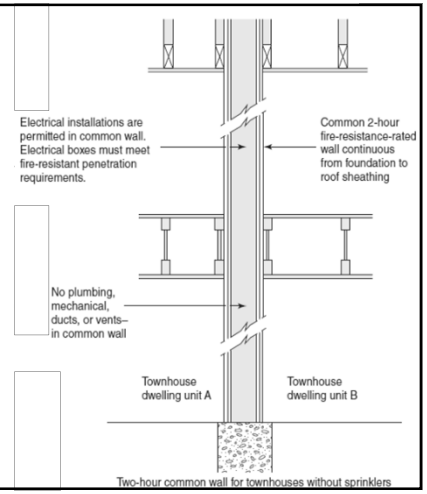
A manufactured home placed on a single family home lot. Must be owned or occupied by a qualified care-giver and the accessory structure is occupied only by the impaired person. The accessory structure must comply with all setbacks and any maximum floor area ratio limits that apply to the primary residential structure. The structure may be required to connect to any water, sewer, and electric utilities serving the property. Only one accessory temporary family care structure is allowed per lot. Other zoning requirements that are applicable to all other accessory structures in that zoning district may also be applied. No signage regarding the presence of the structure is allowed. The structure must be removed within 60 days after care-giving on the site ceases.

Soffit Protection
R302.1.1

- Soffits with a FSD <3 ft. Require one-hour fire protection on the underside.
- Soffits with a FSD <10 ft. Must be protected per sections R302.1.1 & R302.1.2.

Townhomes
R302.2

- 2 hr. continuous separation (foundation to roof) required between unsprinklered townhomes.
- Electrical installations are allowed on the common wall.
- Plumbing or mechanical equipment, ducts or vents are NOT allowed on the common wall.



Membrane Penetrations
(R302.4.2)

There are 4 basic conditions for installing standard electrical boxes on rated walls. (Exception #1)

R302.4.2 Membrane penetrations. Membrane penetrations shall comply with Section R302.4.1. Where walls are required to have a fire-resistance rating, recessed fixtures shall be installed so that the required fire-resistance rating will not be reduced.

Exceptions:

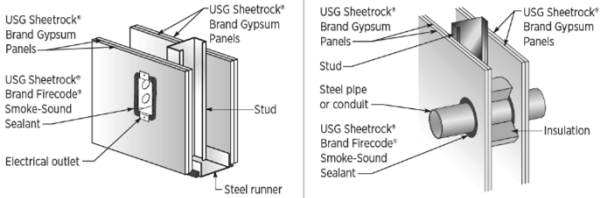
1. Membrane penetrations of not more than 2-hour fire-resistance-rated walls and partitions by steel electrical boxes that do not exceed 16 square inches (0.0103 m^2) in area provided that the aggregate area of the openings through the membrane does not exceed 100 square inches (0.0645 m^2) in any 100 square feet (9.29 m^2) of wall area. The annular space between the wall membrane and the box shall not exceed $^1/_8$ inch (3.1 mm). Such boxes on opposite sides of the wall shall be separated by one of the following:
   1.1. By a horizontal distance of not less than 24 inches (610 mm) where the wall or partition is constructed with individual noncommunicating stud cavities.
   1.2. By a horizontal distance of not less than the depth of the wall cavity where the wall cavity is filled with cellulose loose-fill, rockwool or slag mineral wool insulation.
   1.3. By solid fireblocking in accordance with Section R302.11.
   1.4. By protecting both boxes with *listed* putty pads.
   1.5. By other *listed* materials and methods.
2. Membrane penetrations by *listed* electrical boxes of any materials provided that the boxes have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the *listing*. The annular space between the wall membrane and the box shall not exceed $^1/_8$ inch (3.1 mm) unless *listed* otherwise. Such boxes on opposite sides of the wall shall be separated by one of the following:
   2.1. By the horizontal distance specified in the *listing* of the electrical boxes.
   2.2. By solid fireblocking in accordance with Section R302.11.
   2.3. By protecting both boxes with *listed* putty pads.
   2.4. By other *listed* materials and methods.
3. The annular space created by the penetration of a fire sprinkler provided that it is covered by a metal escutcheon plate.

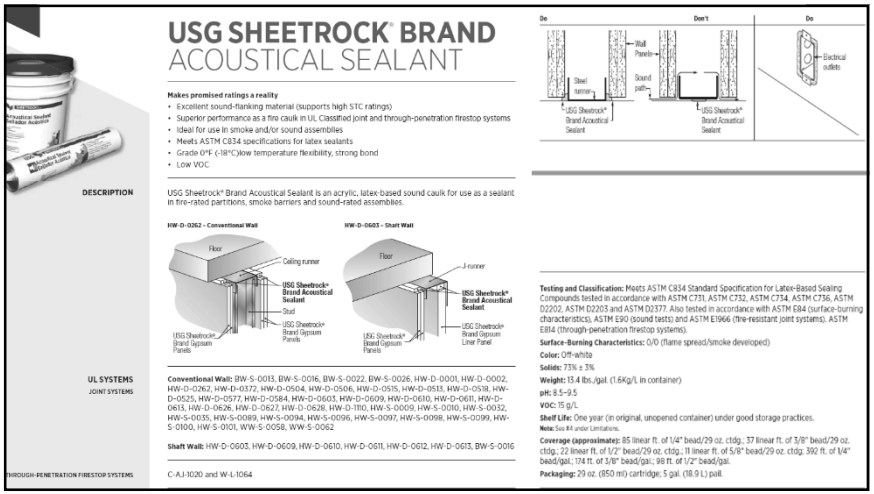
Acoustical Fire Caulk

- **Question: Is acoustical fire caulk allowed?**
- **Answer:** YES. Acoustical sealant is often applied on area separation walls to create an air barrier.
- An air barrier is an optional feature on Area Separation Walls designs. It prevents air leakage, noise transmission, air whistling and dust collection.

Acoustical Fire Caulk

- **Question: Where can acoustical fire caulk be applied?**
- **Answer:** A bead of sealant can be applied around <u>any membrane penetration</u> in the wood studs, the partition perimeter or between wood the gypsum board panels. It can also be applied under the foundation runner or the head of wall and around electrical outlets.





USG SHEETROCK® BRAND ACOUSTICAL SEALANT

Makes promised ratings a reality
- Excellent sound-flanking material (supports high STC ratings)
- Superior performance as a fire caulk in UL Classified joint and through-penetration firestop systems
- Ideal for use in smoke and/or sound assemblies
- Meets ASTM C834 specifications for latex sealants
- Grade 0°F (-18°C)low temperature flexibility, strong bond
- Low VOC

DESCRIPTION

USG Sheetrock® Brand Acoustical Sealant is an acrylic, latex-based sound caulk for use as a sealant in fire-rated partitions, smoke barriers and sound-rated assemblies.

HW-D-0262 – Conventional Wall

HW-D-0603 – Shaft Wall

UL SYSTEMS JOINT SYSTEMS

Conventional Wall: BW-S-0013, BW-S-0016, BW-S-0022, BW-S-0026, HW-D-0001, HW-D-0002, HW-D-0262, HW-D-0372, HW-D-0504, HW-D-0506, HW-D-0515, HW-D-0533, HW-D-0538, HW-D-0525, HW-D-0577, HW-D-0584, HW-D-0603, HW-D-0609, HW-D-0610, HW-D-0611, HW-D-0613, HW-D-0626, HW-D-0627, HW-D-0628, HW-D-1110, HW-S-0009, HW-S-0010, HW-S-0032, HW-S-0035, HW-S-0089, HW-S-0094, HW-S-0096, HW-S-0097, HW-S-0098, HW-S-0099, HW-S-0100, HW-S-0101, WW-S-0058, WW-S-0062

Shaft Wall: HW-D-0603, HW-D-0609, HW-D-0610, HW-D-0611, HW-D-0612, HW-D-0613, BW-S-0016

THROUGH-PENETRATION FIRESTOP SYSTEMS

C-AJ-1020 and W-L-1064

Do / Don't / Do

Testing and Classification: Meets ASTM C834 Standard Specification for Latex-Based Sealing Compounds tested in accordance with ASTM C731, ASTM C732, ASTM C734, ASTM C736, ASTM D2202, ASTM D2203 and ASTM D2377. Also tested in accordance with ASTM E84 (surface-burning characteristics), ASTM E90 (sound tests) and ASTM E1966 (fire-resistant joint systems). ASTM E814 (through-penetration firestop systems).

Surface-Burning Characteristics: 0/0 (flame spread/smoke developed)

Color: Off-white

Solids: 73% ± 3%

Weight: 13.4 lbs./gal. (1.6Kg/L in container)

pH: 8.5–9.5

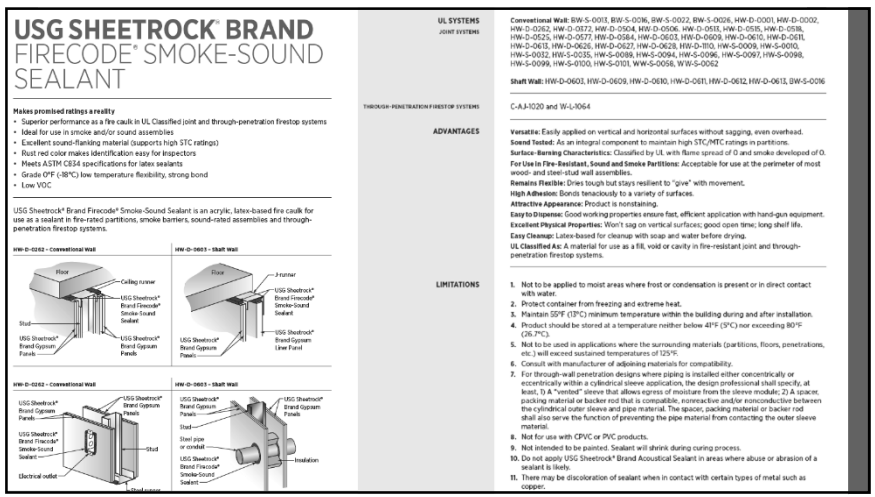
VOC: 15 g/L

Shelf Life: One year (in original, unopened container) under good storage practices.

Note: See #4 under Limitations.

Coverage (approximate): 85 linear ft. of 1/4" bead/29 oz. ctdg.; 37 linear ft. of 3/8" bead/29 oz. ctdg.; 22 linear ft. of 1/2" bead/29 oz. ctdg.; 11 linear ft. of 5/8" bead/29 oz. ctdg. 392 ft. of 1/4" bead/gal.; 174 ft. of 3/8" bead/gal.; 98 ft. of 1/2" bead/gal.

Packaging: 29 oz. (850 ml) cartridge; 5 gal. (18.9 L) pail.



USG SHEETROCK® BRAND FIRECODE® SMOKE-SOUND SEALANT

Makes promised ratings a reality
- Superior performance as a fire caulk in UL Classified joint and through-penetration firestop systems
- Ideal for use in smoke and/or sound assemblies
- Excellent sound-flanking material (supports high STC ratings)
- Rust red color makes identification easy for inspectors
- Meets ASTM C834 specifications for latex sealants
- Grade 0°F (-18°C) low temperature flexibility, strong bond
- Low VOC

USG Sheetrock® Brand Firecode® Smoke-Sound Sealant is an acrylic, latex-based fire caulk for use as a sealant in fire-rated partitions, smoke barriers, sound-rated assemblies and through-penetration firestop systems.

HW-D-0262 – Conventional Wall

HW-D-0603 – Shaft Wall

HW-D-0262 – Conventional Wall

HW-D-0603 – Shaft Wall

UL SYSTEMS JOINT SYSTEMS

Conventional Wall: BW-S-0013, BW-S-0016, BW-S-0022, BW-S-0026, HW-D-0001, HW-D-0002, HW-D-0262, HW-D-0372, HW-D-0504, HW-D-0506, HW-D-0515, HW-D-0533, HW-D-0538, HW-D-0525, HW-D-0577, HW-D-0584, HW-D-0603, HW-D-0609, HW-D-0610, HW-D-0611, HW-D-0613, HW-D-0626, HW-D-0627, HW-D-0628, HW-D-1110, HW-S-0009, HW-S-0010, HW-S-0032, HW-S-0035, HW-S-0089, HW-S-0094, HW-S-0096, HW-S-0097, HW-S-0098, HW-S-0099, HW-S-0100, HW-S-0101, WW-S-0058, WW-S-0062

Shaft Wall: HW-D-0603, HW-D-0609, HW-D-0610, HW-D-0611, HW-D-0612, HW-D-0613, BW-S-0016

THROUGH-PENETRATION FIRESTOP SYSTEMS

C-AJ-1020 and W-L-1064

ADVANTAGES

Versatile: Easily applied on vertical and horizontal surfaces without sagging, even overhead.

Sound Tested: As an integral component to maintain high STC/MTC ratings in partitions.

Surface-Burning Characteristics: Classified by UL with flame spread of 0 and smoke developed of 0.

For Use in Fire-Resistant, Sound and Smoke Partitions: Acceptable for use at the perimeter of most wood- and steel-stud wall assemblies.

Remains Flexible: Dries tough but stays resilient to "give" with movement.

High Adhesion: Bonds tenaciously to a variety of surfaces.

Attractive Appearance: Product is nonstaining.

Easy to Dispense: Good working properties ensure fast, efficient application with hand-gun equipment.

Excellent Physical Properties: Won't sag on vertical surfaces; good open time; long shelf life.

Easy Cleanup: Latex-based for cleanup with soap and water before drying.

UL Classified As: A material for use as a fill, void or cavity in fire-resistant joint and through-penetration firestop systems.

LIMITATIONS

1. Not to be applied to moist areas where frost or condensation is present or in direct contact with water.
2. Protect container from freezing and extreme heat.
3. Maintain 59°F (13°C) minimum temperature within the building during and after installation.
4. Product should be stored at a temperature neither below 41°F (5°C) nor exceeding 80°F (26.7°C).
5. Not to be used in applications where the surrounding materials (partitions, floors, penetrations, etc.) will exceed sustained temperatures of 125°F.
6. Consult with manufacturer of adjoining materials for compatibility.
7. For through-wall penetration designs where piping is installed either concentrically or eccentrically within a cylindrical sleeve application, the design professional shall specify, at least, 1) A "vented" sleeve that allows egress of moisture from the sleeve module; 2) A spacer, packing material or backer rod that is compatible, nonreactive and/or nonconductive between the cylindrical outer sleeve and pipe material. The spacer, packing material or backer rod shall also serve the function of preventing the pipe material from contacting the outer sleeve material.
8. Not for use with CPVC or PVC products.
9. Not intended to be painted. Sealant will shrink during curing process.
10. Do not apply USG Sheetrock® Brand Acoustical Sealant in areas where abuse or abrasion of a sealant is likely.
11. There may be discoloration of sealant when in contact with certain types of metal such as copper.

- **Question: Are H-studs allowed in area separation walls instead of the C channels?**
- **Answer:** NO.
  - Last year some illustrations of details U336 and U347 were showing that H studs can be used horizontally at 24" o.c. We contacted US Gypsum, National Gypsum and UL and they all confirmed that those drawings were incorrect, and that the assembly was not tested using horizontal H-studs. The drawings are now corrected and GA has published a document explicitly saying to use back-to-back C-runners only, which are designed to friction-fit the vertical H studs.)
  - **Refer to the revised UL details and/or document GA-620-2019.**

GA-620-2019

GYPSUM AREA SEPARATION FIREWALLS

Note: Refer to manufacturer's installation instructions for specific limiting heights and clip spacing requirements for walls exceeding 44' (13 400 mm) in total height.

12. Begin the next course of the Gypsum Area Separation Firewall by attaching a 2" (51 mm) C-runner (with legs up) to the previously installed top C-runner of the lower course. This back-to-back C-runner installation allows for the progressive erection of the Gypsum Area Separation Firewall one floor at a time. Secure the two C-runners together with two 3/8" (10 mm) Type S pan head screws 24" (610 mm) o.c. Stagger back-to-back C-runner joints a minimum of 12" (300 mm).

Note: Always use back-to-back C-runners between courses in Gypsum Area Separation Firewalls. Do not substitute a single H-stud for the specified back-to-back C-runners.

- **Question: What can I do about a damaged rated wall after it has passed inspection?**
- **Answer:** This happens all the time, right after a wall passes inspection, another trade comes in and damages it. So instead of replacing the whole panel or getting an engineering judgment, the inspector could accept the GA patch method **(at his discretion).**
- Refer to document GA 225-2019.

- NOTE: For a multilayer assembly the gypsum panel joints are staggered from one layer to the next. The repair joints should not line up from one layer to the next. To accommodate that requirement, the base layer repair patch should be smaller than the face layer.

GYPSUM ASSOCIATION

GA-225-2019
REPAIR OF FIRE-RATED
GYPSUM PANEL PRODUCT SYSTEMS

Fire-rated gypsum panel product systems may be damaged during the life cycle of buildings. To maintain the required fire-rated separation between occupancies or areas, damaged systems must be repaired so that they are restored to their original fire-resistive condition. The repair procedures should be dictated by the severity of the damage.

Small holes (such as those caused by a doorknob) can be repaired by patching (see Figure 1). To maintain the integrity of the surface membrane, a gypsum panel product patch must be mechanically secured to blocking in the opening; attachment with joint compound material only is not acceptable. The patching material should be cut from type X or proprietary type X gypsum panel product of a thickness equal to the original panel so that the patch is in the same geometric shape as, but slightly larger than, the damaged area. The damaged area is then further enlarged to match exactly the size of the patch (see Figure 2). Use caution when cutting or fastening into stud cavities to avoid electrical shock or causing water leaks. Insulation, if present, must be restored. Metal runner track is secured to the edges of the frame opening (see Figure 3). The patch is screw-attached to the exposed face of the runner track with fasteners a maximum of 8 in. (200 mm) on center (see Figure 4). The patch should be treated with tape and joint compound to restore appearance, fire-resistance qualities, and acoustical performance (see Figures 5 and 6).

NOTE: Overlapping of joint tape can result in finishing problems.

Proprietary clip products are available that provide mechanical support for patching. Manufacturers of these products should be contacted for information.

If damage covers more than 100 in.^{2} (700 cm^2) in 100 ft^2 (10 m^2) of wall or ceiling area, all materials in the damaged area must be removed back to the original framing to make the repair. Framing in the area to be repaired should be inspected and replaced if necessary without increasing original framing spacing. Replacement panels should be cut to fill the opening and mechanically attached to the framing. Ends and edges of the panel that are not backed by framing materials should be supported with metal runner track. The repaired area should be finished with tape and joint treatment compound as necessary.

Multiple-layer systems typically require that joints be staggered between layers. Proper repair of multiple-layer systems requires that face layers of panels be removed beyond the base layer joint to retain the staggered joint feature.

To improve the appearance of large areas that are structurally sound but aesthetically unacceptable, a new layer of regular or type X gypsum panel may be installed with mechanical fasteners without adversely affecting the fire-resistance rating or acoustical performance.

GA-225-2019
REPAIR OF FIRE-RATED GYPSUM PANEL PRODUCT SYSTEMS

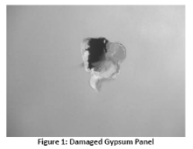


Figure 1: Damaged Gypsum Panel


Figure 2: Square Off Damaged Area

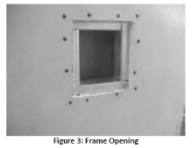


Figure 3: Frame Opening

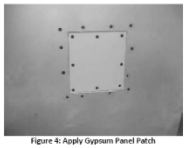


Figure 4: Apply Gypsum Panel Patch

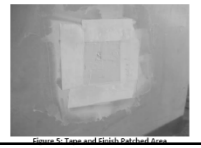


Figure 5: Tape and Finish Patched Area


Figure 6: Redecorate Repaired Area

Townhouse Roof protection:

Options:

1. A 30-inch-high parapet (2hr. rated).

2. Fire protection for a distance of 4 feet on each side of the separating wall.

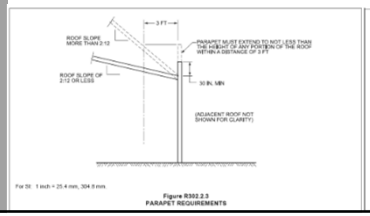


Figure R302.2.3
PARAPET REQUIREMENTS

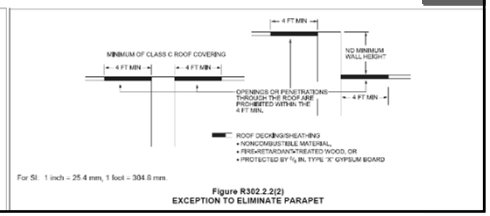
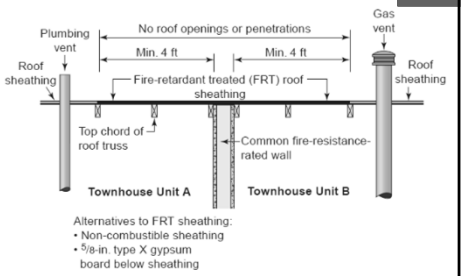


Figure R302.2.2(2)
EXCEPTION TO ELIMINATE PARAPET

Townhouses without parapets

Roof penetrations are prohibited within 4 ft. of the separating wall:

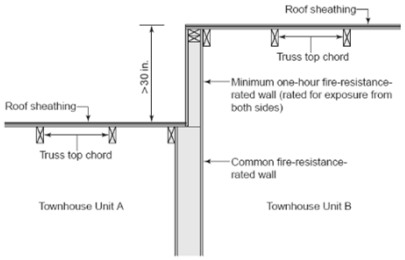
- Skylights
- Roof windows
- Gas vents
- Plumbing vents
- Exhaust outlets
- Air intakes
- Ridge vents
- Roof vents



Alternatives to FRT sheathing:
- Non-combustible sheathing
- 5/8-in. type X gypsum board below sheathing

Townhouse roof separation (R302.2.2.2 - #3)

- Townhouse separation for roofs with greater than 30-inch height difference.



Roof protection

For townhouses without parapets, roof penetrations are prohibited within 4 ft. of the separating wall:

- Skylights
- Roof windows
- Gas vents
- Plumbing vents
- Exhaust outlets
- Air intakes
- Ridge vents
- Roof vents •

Additional Soffit Protection for Townhomes. (R302.2.5)

- Wood sheathing is ¾" (not $^{23}/_{32}$").
- Vents are not allowed within 4 ft. of fire walls.

Overhang Protection for Townhomes. (R302.2.6)

Up to 12" overhangs may encroach the property line if:

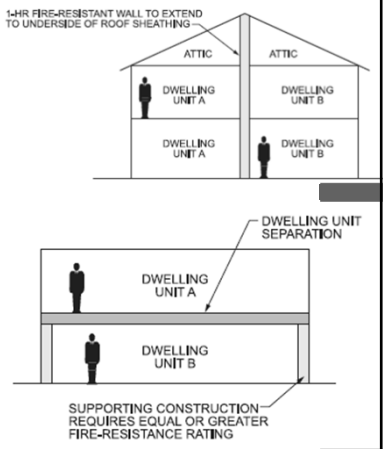
1. The rated wall is tight to the roof deck.

2. Eaves are non-combustible or FRT.

3. Eaves have 5/8" Type X GWB or equivalent on the underside.

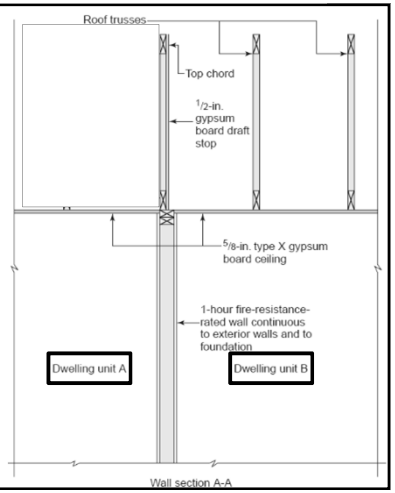
Duplex separation
R302.3
(horizontal or vertical)

- One-hour fire-resistance-rated separation between the dwelling units of a two-family dwelling, continuous to the exterior walls or roof.



Duplex separation alternative

- ⅝-inch Type X gypsum board ceiling & the framing supporting the ceiling is protected with ½" gypsum.
  AND
- A½-inch gypsum board draft stop in the attic area.



Through Penetrations (R302.4.1)

Exceptions:

- 1. Concrete grout or mortar can be used in on concrete or masonry walls.
- 2. Materials per ASTM 119 or UL 263.

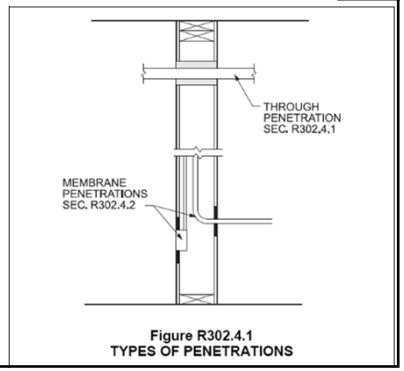


Figure R302.4.1
TYPES OF PENETRATIONS

Through Penetrations (R302.4.1)

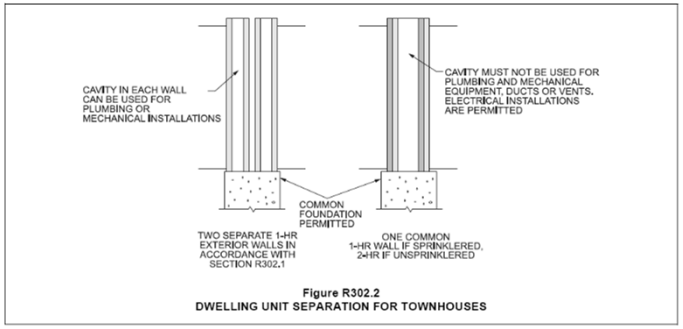


Figure R302.2
DWELLING UNIT SEPARATION FOR TOWNHOUSES

Membrane Penetrations (R302.4.2)

Exceptions:

- 1. Concrete grout or mortar can be used in on concrete or masonry walls.
- 2. Approved materials per ASTM 119 or UL 263.

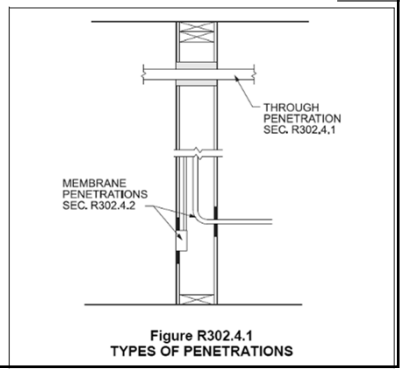


Figure R302.4.1
TYPES OF PENETRATIONS

Electrical box penetrations. R302.4.2

- NOTE: Not applicable to area separation walls.

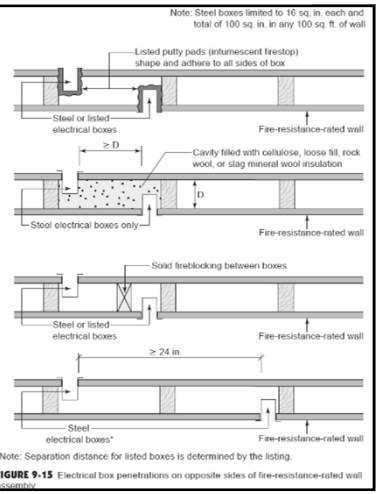
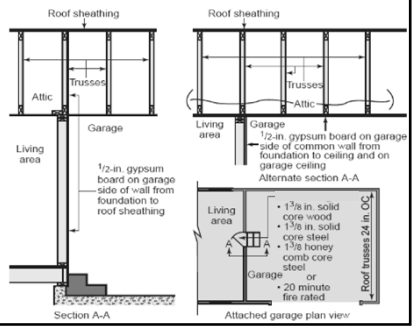


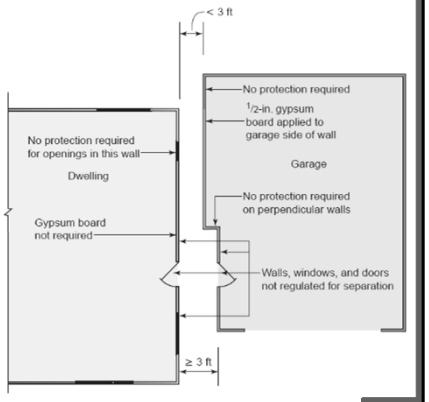
FIGURE 9-15 Electrical box penetrations on opposite sides of fire-resistance-rated wall assembly

Dwelling-garage fire separation. R302.6

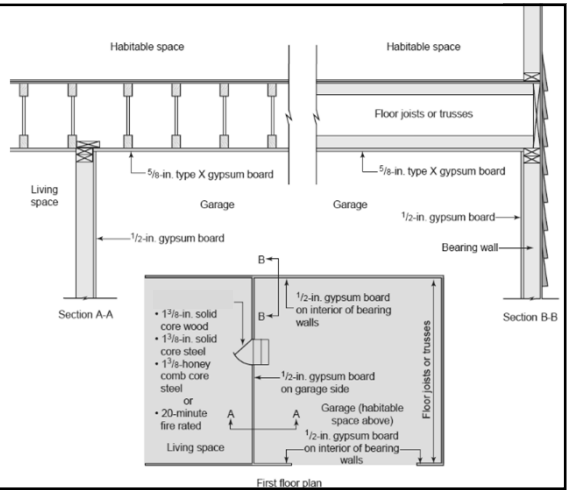
- ½-inch GWB required.
- ⅝-inch Type X GWB ceiling if there is a habitable room above.
- The ceiling's bearing walls require ½-inch GWB on the interior surface.
- Sleeping rooms require 20-min. door or approved equivalent.



Dwelling-garage less than 3 ft. away, on the same lot. R302.6

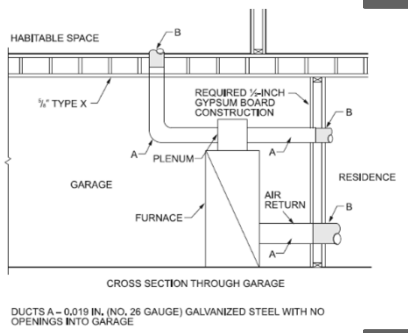


Dwelling-garage with habitable space above.
R302.6



Dwelling-Garage Ducts R302.5

No. 26 ga. minimum.



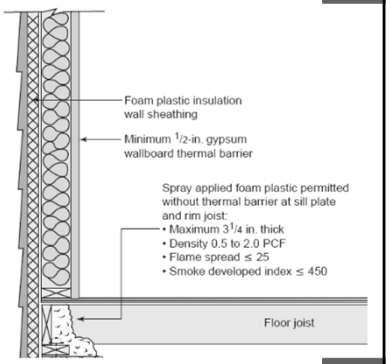
Under Stair Protection (R302.7)

- Open storage = no protection.
- Enclosed storage = ½" GWB required on the enclosed side.

Foam Plastic (R16.4)

Must be isolated from the dwelling by a ½" GWB or an equivalent thermal barrier.

- See exceptions for attics and crawlspaces R316.5.3 & R316.5.4. entered only for maintenance or repairs



Flame Spread Index R302.9

- Class C required.
- Does not apply to picture mold, chair rails, baseboards , handrails, wallpaper etc.

Insulation R302.10.1

- Insulation, including facings used as vapor retarders or as breather papers, must be class A.
- If the paper is in contact with a material, there is no airspace to pose risk and Class A is not required.
- Cellulose insulation is regulated by CAN/ULC S102.2, SDI must be < 550.
- Plastics are regulated by R316.

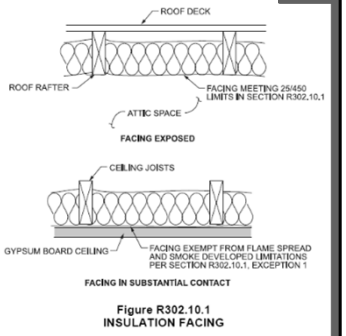
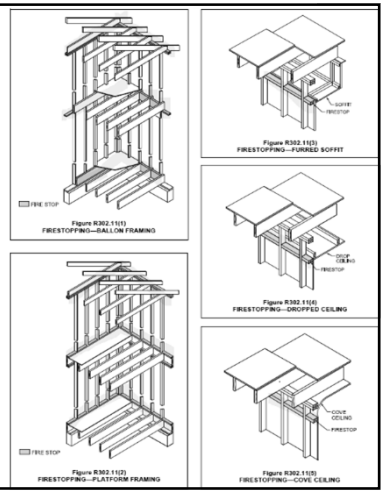


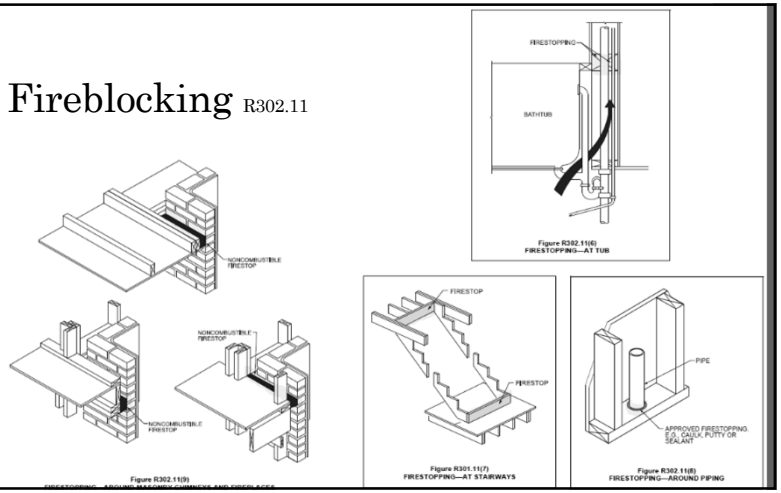
Figure R302.10.1
INSULATION FACING

Fireblocking R302.11

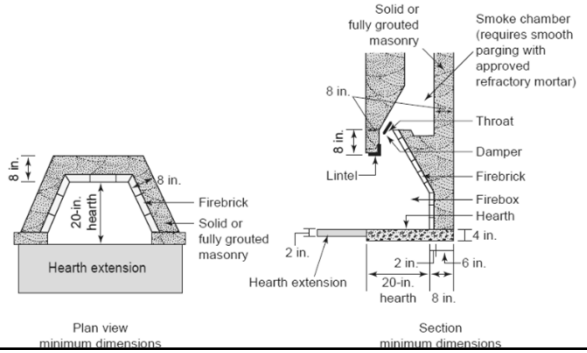
- Building materials installed to resist the free passage of flame to other areas of the building through concealed spaces.



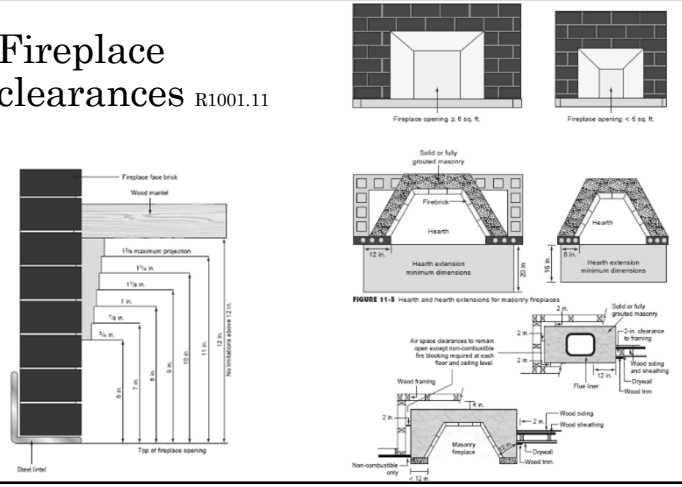
Fireblocking R302.11



Fireplace Hearth Extensions R1001.9

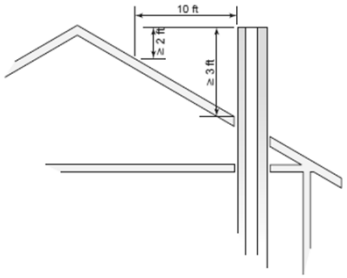


Fireplace clearances R1001.11



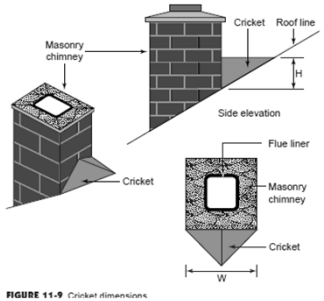
Chimney termination R1003.9

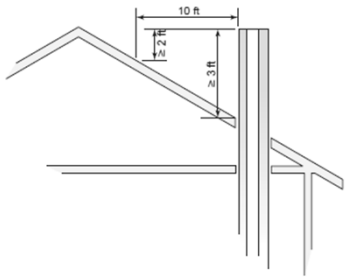
- The requirements of this section shall apply as well to outdoor chimneys in proximity to the home.



Chimney termination R1003.9

Roof Slope	Height
12:12	⅛ of width
8:12	⅛ of width
6:12	¼ of width
4:12	⅛ of width
3:12	⅛ of width

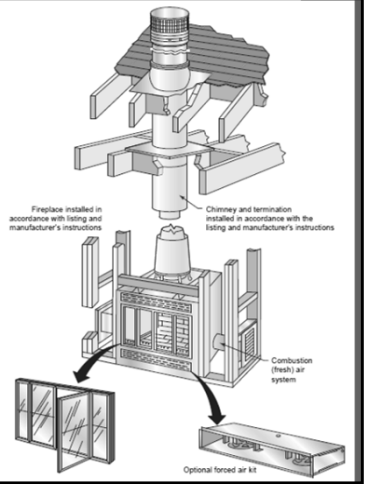




Manufactured Fireplaces & Chimneys

R1004, R1005

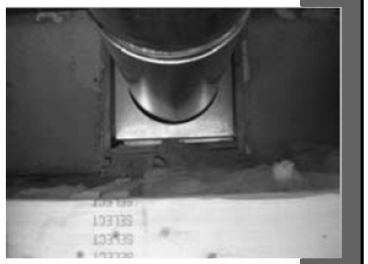
- Listed per UL 127.
- Hearth extension per manufacture's specifications.
- 30 degree max. offset.
- No more than 4 elbows.



Firestop

R1004, R1005

Q: The flue manufacturer states that you can't put firestopping caulk at ceiling levels. Because expansion and contraction is necessary. Do we leave an opening ?



A: The manufacturer is correct per UL 127-7.3 an opening is required.

However, per UL 127- 7.1.4. **" The construction of a fireplace shall not void the firestopping required between spaces of a building when the fireplace and its chimney are installed in accordance with the manufacturers instructions."**

So what can we do? We may use rockwool. It is non-combustible and allows expansion and contraction.

NOTE: Review the manual. Some appliances may require 1- 36 inches of clearance to combustible materials.

Questions?

(any topic)

March 2020

Home Safety

1. Room Areas

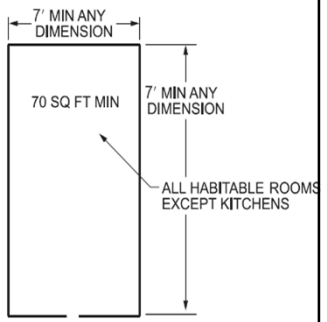
Minimum area
R304

Overcrowding creates unhealthy and unsafe living conditions, such as:

- Moisture accumulation.
- Odors.
- Disease transmission.
- Inadequate ventilation.

Minimum Dimensions
R304.1, R304.2

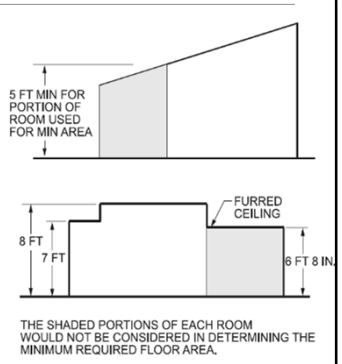
- **70 sf.** min. for habitable rooms other than kitchens. (new).
- The smallest dimension shall be **7 ft. min.** (except kitchens).



Room Size Calculation
R304.3

Portions not included in the calculation:

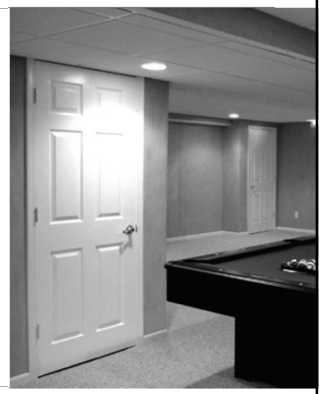
- Sloped ceilings, ceilings under **5 ft.**
- Furred ceilings measuring less than **7 ft.**



Min. Ceiling Height
R305.1

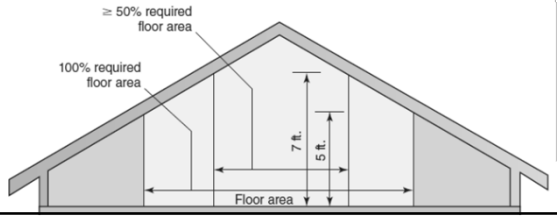
(NEW)

- Habitable spaces and hallways: **7'-0".**
- Bathrooms, toilet rooms and laundry rooms: **6'-8".**



Sloped Ceilings
R305.1 exception #1

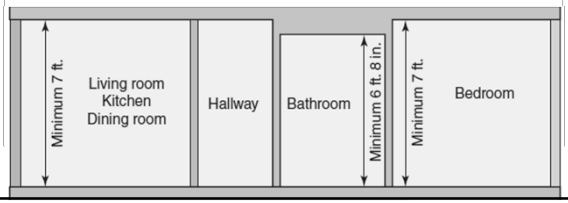
- Half of the required room area must be 7'-0" high.
- The ceiling height shall be no less than 5'-0.



Bathrooms and Showers
R305 exception #2

(NEW)

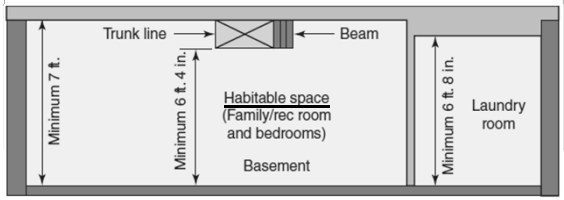
- **The ceiling height above bathroom and toilet room fixtures** shall be such that the fixture is capable of being used for its intended purpose.
- **A shower or tub with a showerhead** shall have a ceiling height of not less than **6'-8"** above an area of not less than **30" by 30"** at the showerhead.



Non-habitable spaces and basements

R305.1.1 exception #3
R305.1.1 exception

- **Beams, girders, ducts or other obstructions** in *habitable spaces* shall be permitted to project to within 6′-4″ of the finished floor.
- **Portions of *basements* that <u>do not</u> contain *habitable space* or hallways** shall have a ceiling height of not less than 6′-8″.
  - **At beams, girders, ducts or other obstructions,** the ceiling height shall be not less than 6′-4″ .



2. Means of Egress

Exterior egress door

R311.2

- One 3′-0″ x 6′-8″ (nominal) exterior door.
- Side-hinged.
- No double keyed deadbolt.
- Shall not pass through the garage.

Exterior egress door

R302.7, R311.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Double Door Exits

Code: 2018 Residential Code **Date:** March 21, 2019
Section: R311.2

Question:
Are double doors permitted for the required exit if they have a total door opening equal to 36 inches?

Answer:
Yes. These doors are typically two 30-inch doors or two 32 inch doors. They can not have a stationary center mullion, but one leaf can have a toe and/or head bolt. The other leaf must be readily openable from the egress side without the use of a key or special knowledge or effort.

Exterior egress door
R302.7, R311.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Exterior Egress Door Dimensions

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R311.2

Question:
Section R311.2 specifies the requirements for the minimum dimensions of at least one exterior egress door, but other exterior doors are not required to comply with the minimum dimensions. Are other exterior egress doors required to meet any minimum dimensions?

Answer:
Yes. Exterior egress doors, in addition to the one required, must meet the 78 inch minimum height requirement but are not required to meet the 32 inch minimum width. This minimum height dimension is required to be maintained in exterior egress doors to provide the inherent feeling of safety that a door utilized for egress should afford. Other exterior doors, such as a balcony access or ornamental opening, utilized in non-egress applications that are not intended for use in the evacuation of an occupied space are not required to meet the minimum dimensions.

Floors and Landings at exterior doors
R311.3

- There shall be a landing or floor <u>on each side</u> of each exterior door.
- The width of each landing shall be not less than the door served.
- Every landing shall have a dimension of not less than 36" measured in the direction of travel.
- The slope at exterior landings shall not exceed 1/4 unit vertical in 12 units horizontal (2 %).

Floors and Landings at exterior doors
R311.3 exception

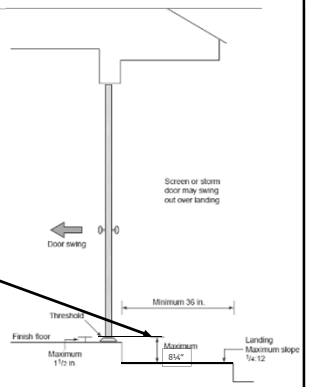
French balcony exception:

R311.3 Floors and landings at exterior doors. There shall be a landing or floor on each side of each exterior door. The width of each landing shall be not less than the door served. Every landing shall have a dimension of not less than 36 inches (914 mm) measured in the direction of travel. The slope at exterior landings shall not exceed $^1/_4$ unit vertical in 12 units horizontal (2 percent).

Exception: Exterior balconies less than 60 square feet (5.6 m²) and only accessible from a door are permitted to have a landing less than 36 inches (914 mm) measured in the direction of travel.

Landings at exterior egress doors
R311.3

- Required on <u>both sides</u> of the door.
- The landing must be as wide as the door & 36" deep min.
- A step down is allowed **IF** the door swings in.

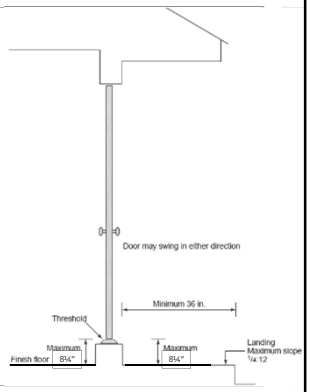


Exception: The exterior landing or floor shall be not more than $^7/_8$ inches (210 mm) below the top of the threshold provided the door does not swing over the landing or floor.

Landings at exterior non-egress doors
R311.3.2

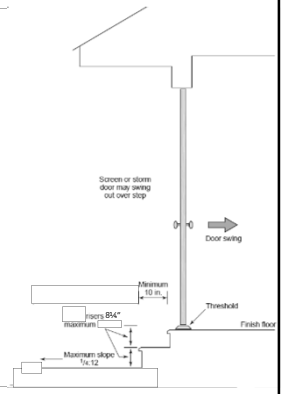
At non-egress doors:

- The floor or landing on either side of the door is permitted to be 8 ¼" inches below the top of the threshold.
- The door may swing in either direction



Landings at exterior non-egress exterior doors
R311.3.2 exception

A landing is not required outside **IF t**he door swings in.



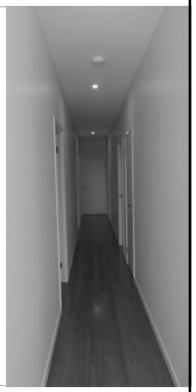
Storm & screen doors
R311.3.3

Storm and screen doors shall be permitted to swing over exterior stairs and landings.

Means of egress
R311.6

Hallways:

- The width of a hallway shall be not less than **3 ft**. measured from the finished surface of the walls.



Means of egress
R311.6.1

Interior egress doors:

- Size: **2′-6″ x 6′-8″** (nominal)
- Readily openable (i.e. no double-keyed dead bolts).

Note: This is a Mecklenburg County Code Interpretation, not a code requirement.

Q:
What's the difference between a hallway and a cased opening?

A:
A cased opening has a 12″ max. depth per MCCE.

Hallway: 3′-0″ min.

Cased opening: 2′-6″ max. up to 12″ deep.

Means of egress
R302.7

Stairs:

- The code requires limited **½″ gypsum** protection on the underside of stairs when the space below is enclosed.

Stairs rise
R311.7.3, R311.7.5.1

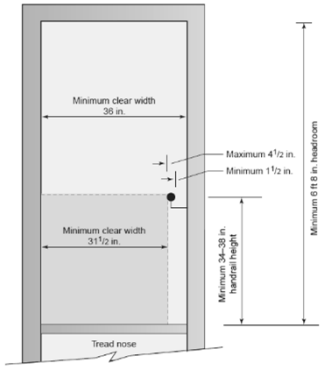
- Vertical rise **12′-3″** max. with no landings.

Stairway width and height.
R311.7.1

Stairway width (wall to wall):
- Egress stairways shall be **36" wide.**
- Non-egress stairways shall be permitted to be **26" wide.**

Stairway width (between handrails):

- The min. width between one handrail and the wall is **31 ½".**
- The min. width between two handrails is **27".**



Stairs
R311.7.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Projections on Stairway Walls

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R311.7.1

Question:
In one- and two-family dwellings may items other than railings, which are specifically addressed in R311.7 .1, be mounted on stairway walls and ceilings?

Answer:

Yes, with limitations. Elements such as trim, stringers or other items may be on the wall below the handrail or handrails as long as they do not exceed projection limits allowed for handrails. These items must not reduce the required clear stairway dimension allowed for handrails. Similarly, elements may project into the stairway above the 6 feet 8 inches requirement of Section R311.7.2. See 2015 IRC commentary Figure R311.7.1 attached below. The allowed projection areas are shaded.

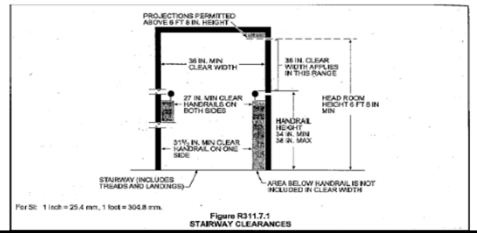
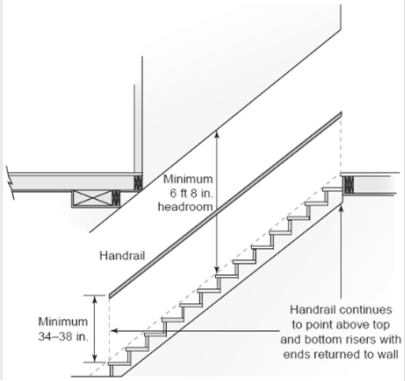


Figure R311.7.1
STAIRWAY CLEARANCES

Stairway headroom
R311.7.2

The min. 6′-8″ includes the flight of stairs and the landings serving the stairway.



Stairway headroom and handrail height
R311.7

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Fixed Stairway Upper Landing Headroom

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R311.7.2

Question:
What is the headroom requirement for the area at the top of a permanent stairway? The stairway does not have a door at the top.

Answer:
Section R311.7.2 defines headroom requirements for stairways. It states:
"The minimum headroom in all parts of the stairway shall not be less than 6 feet, 8 inches."

"All parts" of the stairway includes landings. Therefore, there should be a minimum floor area of 36"x36" at the top of the stairway with a minimum headroom of 6'-8". These clearances are minimums that are required for safety of the occupants for egress and for fire fighting personnel to access the space.

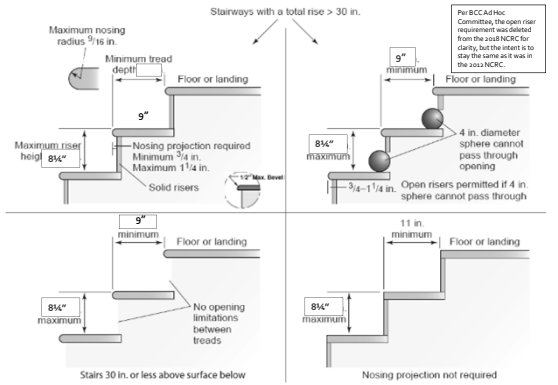
Stairway headroom

R311.7.2 exception #1

- This exception allows us to have a ceiling offset of **4 ¾"** maximum, without being considering it a projection into the required stairway headroom.
- This exception only applies at the side of stairs.

Stair treads, risers and nosings.

R311.7.5

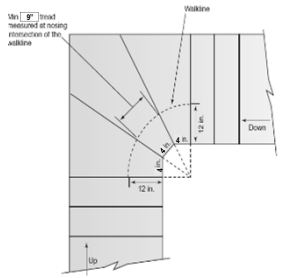


Walkline

R311.7.4

Deleted

- Section R311.7.4 Walkline, was deleted from the NCRC.
- Because sections 311.7.5.2.1 (winder threads) and section R311.7.10.1 (spiral stairways) continue to reference the walkline we must borrow the definition from the NCBC.



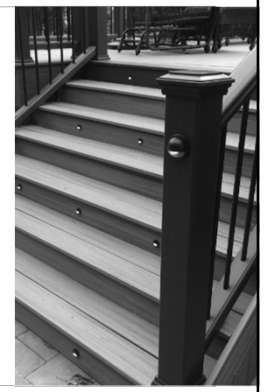
R201.3 Terms defined in other codes. Where terms are not defined in this code such terms shall have the meanings ascribed in other code publications of the North Carolina Building Code Council.

Exterior plastic composite stair threads

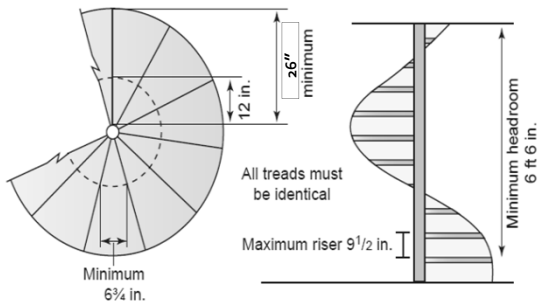
R311.7.5

NEW

In addition to the requirements of Section R311.7.5, stair treads made of wood/plastic composite materials must be installed and labeled per ASTM D7032.



Spiral stairways
R311.7.10.1



Bulkhead enclosures
R311.7.10.2

This section exempts exterior bulkhead enclosure stairways (non-egress) from the landing stairway and handrail requirements.

Mezzanines
R325

NEW

Mezzanine section.

The requirements are similar to the commercial code.

Bowed thread stairways
R311.7.10.3

- At no point shall the tread be less than **9".**
- Each bowed tread is uniform with other bowed treads with no more than **3/8-inch** variance.

Ship's ladders
R311.7.12

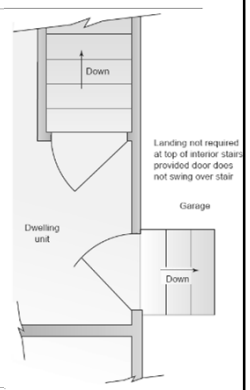
- A ship's ladder cannot be used as an element of a means of egress.
- Must be at least 20" wide, as measured at and below handrails.
- Handrails shall be provided on both sides, be continuous and graspable, per code.

Ramps
R311.8

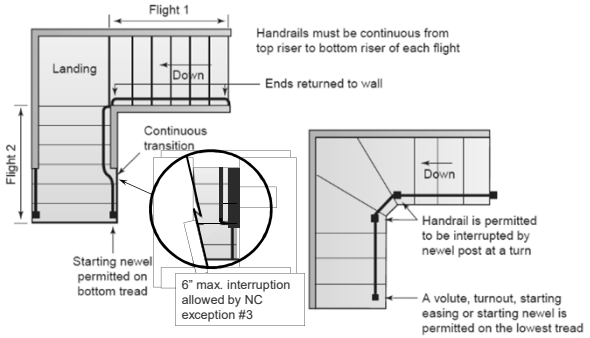
- Section R311.8 states the code requirements for ramps when they are used to access, or are located, within a dwelling.
- Egress ramp: 1:12 slope , two handrails.
- Non-egress ramp: 1:8 slope one handrail. (new)
- Landings are 36" min. in the direction of travel.

Interior landings
R311.7.6

- A floor or landing is required at the top and bottom of stairs.
- An exception to the landing requirement allows a door at the top of an interior flight of stairs, provided the door does not swing over the step.

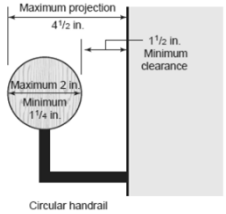


Handrail Continuity
R311.7.8



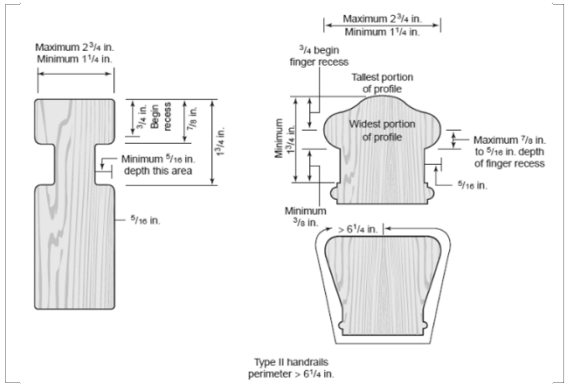
Handrail shapes and graspability.
R311.7.8

- Handrails must be securely anchored to resist a single concentrated load of 200 pounds applied in any direction.
- Any shape, type or size of handrail the equivalent graspability can be accepted.



Handrail shapes and graspability.
R311.7.8

Other shapes, types or sizes equivalent in graspability could be accepted.



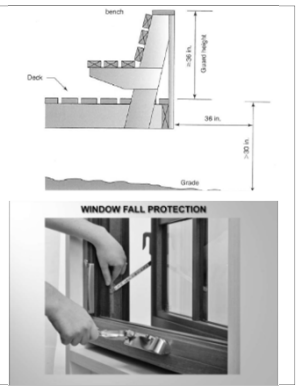
3. Fall protection

Guards
R312.1

Section Reorganized.

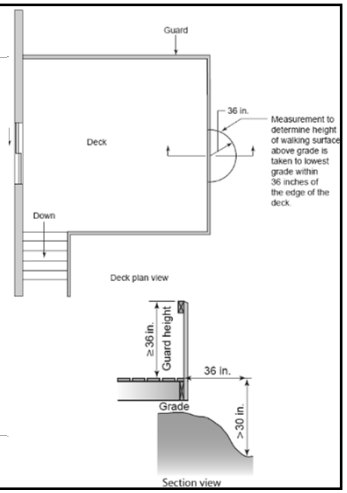
Guards no longer required at fixed seating.

Window sill requirements relocated and better defined.



Guards
R312.1

The code requires a minimum 36-inch-high guard as protection against falling from a walking surface to a lower surface that is more than 30 inches below.



Guards
R312.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Guards On Retaining Walls

Code: 2018 Residential Code **Date:** April 10, 2019
Section: R404.4

Question:
When are guards required on retaining walls?

Answer:
Section R404.4 requires engineering design for the following residential retaining walls and are therefore required to be permitted and inspected:

1. All retaining walls with an unbalanced condition exceeding 48 inches
2. All retaining walls that cross over property line
3. All retaining walls that support buildings and their accessory structures.

Section R312.1.1 states in part; "Guards shall be located along open-sided walking surfaces, including stairs, ramps and landings, that are located more than 30 inches (762 mm) measured vertically to the floor or grade below…." The Commentary for Section R312.1 states: "The guard provisions of this code address the issue of providing protection for occupants from falling off of any elevated walking surface."

Guards complying with R312 must be included on any of the above mentioned retaining walls when the finished area on the high side of the wall is more than 30 inches above the grade below and part of an egress route or other dedicated walking surface.

Guards
R312.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Guard Rails on Screened Porches

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R312

Question:
On a screened porch that has a floor more than 30" above the adjacent grade, are horizontal or vertical members required to prevent the passage of a 4" sphere?

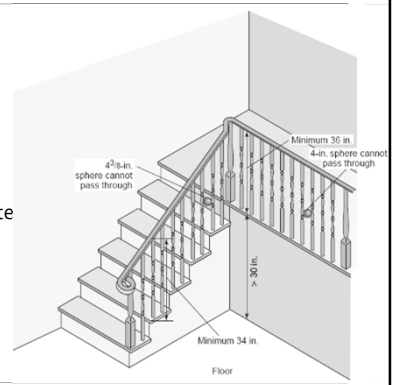
Answer:
Section R312.1.2 requires that a guardrail shall be a minimum of 36 inches in height above the walking surface. Section R312.1.3 requires that vertical pickets be spaced less than 4 inches apart. The guardrail is installed to prevent people or large objects from falling to the floor or grade below. The pickets are installed to prevent children or small objects from passing through the guardrail.

Screen may be accepted in accordance with Section 105 of the NC Administrative Code as an alternate method to replace the pickets provided all of the following conditions are met:

- Guardrails shall be installed horizontally at 36 inches and 18 inches above the walking surface.
- Guardrails shall be capable of resisting a 200 pound concentrated load applied in any direction at any point along the rail (ref. Table R301.5).
- The screen and the screen attachment shall be capable of resisting a 50 psf uniform live load (ref. Table R301.5) from the direction of the protected raised walking surface.

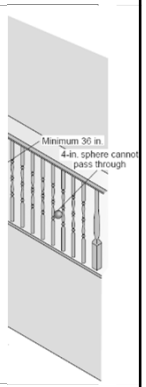
Guards
R312.1

At the sides of stairs, the minimum guard height is reduced to 34 inches to correlate with the minimum handrail height.



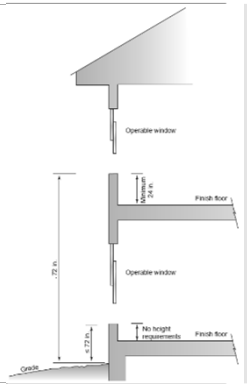
Guards
R312.1

Guards also must be constructed in such a way that a 4-inch sphere will not pass through



Window-sill height
R312.2

- Fall protection can be achieved by installing a barrier or limiting the dimensions of the window opening.
- ASTM F 2090 regulates both window opening control devices and window fall prevention devices.



Window-sill height
R312.2

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Window Sill Height Measurement to Porch Roof

Code: 2018 Residential Code **Date:** May 2, 2019
Section: R312.2.1

Question:
Is a porch roof that is less than 6 feet below a second story window considered a "surface below" for purposes of applying Section R312.2.1 – Widow Sills?

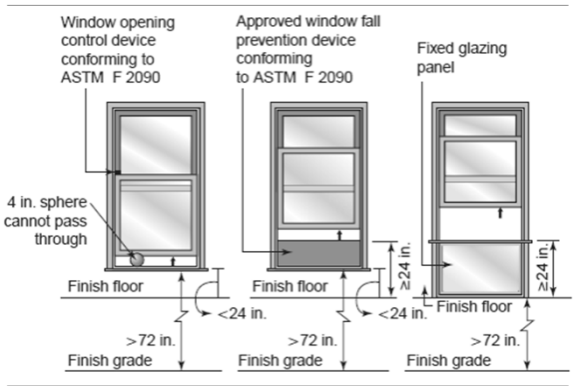
Answer:
Yes, if the porch roof has a slope of 1:48 slope or less and the porch roof is 3 feet wide. If the porch roof either has a slope greater than 1:48 or has a width less than 3 feet, then it is not considered a "surface below".

Explanation:
Section R312.2.1 is intended to prevent small children from falling vertically from a window more than 6 feet to a surface below. Apparently, a distance more than 6 feet is considered by the code to be an unsafe distance for children to fall.

A porch roof with a slope of 1:48 or less (1/4" fall in a 12" run) could be considered such a surface. Since the roof surface is almost horizontal except for the 1:48 drainage slope it is unlikely that a child that fell from the window would continue to roll; so, the fall should terminate at the porch roof if the roof surface is sufficiently wide.

Section R312.1.1 will require a guard where there is a drop of 30 inches or more measured to a horizontal point within 3 feet of the upper walking surface. Since the opening requirements of Section R312.2.1 are intended to act as a guard, it appears reasonable to apply the 3-foot horizontal distance to the porch roof (see Figure A). The porch roof should, therefore, be a minimum of 3 feet wide to be considered a "surface below" the window.

Alternatives to the 24" window sill height.
R312.2

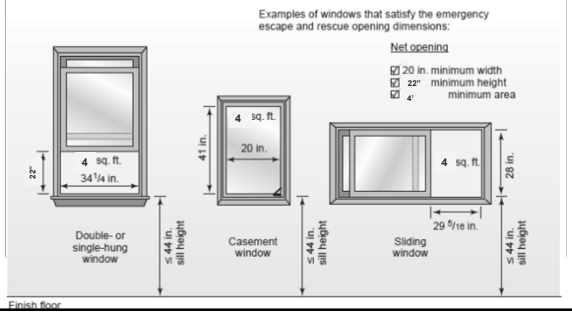


Emergency escape and rescue windows
R310.2.1

R310.2.1 Minimum opening area. Emergency and escape rescue openings shall have a minimum net clear openable area of 4 square feet (0.372 m2). The minimum net clear opening height shall be 22 inches (558 mm). The minimum net clear opening width shall be 20 inches (508 mm). Emergency escape and rescue openings must have a minimum total glazing area of not less than 5 square feet (0.465 m2) in the case of a ground floor level window and not less than 5.7 square feet (0.530 m2) in the case of an upper story window.

Emergency escape and rescue windows
R310.2.1

- Total glazing @ **grade floor** : **5.0 s.f.**
- Total glazing @ **upper story**: **5.7 s.f.**



Emergency escape and rescue windows
R310.2.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Emergency Escape and Rescue Opening Minimum Size

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R310.2.1

Question:
What is the difference in the 4.0 square feet minimum net clear opening requirement and the minimum glass area requirement for emergency escape and rescue openings?

Answer:
The 4.0 square feet minimum net clear opening refers to the opening required when the sash is in the fully open position. This opening is expected to be used by the occupant for emergency escape.

The 5.0 and 5.7 minimum glass area requirement is the size of the window opening when all the sashes are removed. This opening size is based on the minimum required opening for a rescue worker to enter and remove an occupant. Also, it expected that the rescue worker has the equipment required to knock the sash(s) out for access. The 5.7 square feet opening size for the second and third floors is to account for the additional area needed to dismount a ladder and enter the opening.

Emergency escape and rescue windows
R310.2.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Emergency Escape and Rescue Opening for Casement Windows

Code: 2018 Residential Code **Date:** April 5, 2019
Section: R310

Question:
A particular casement window unit has two swinging sashes and one fixed pane between the two swinging sashes. At least one of the swinging sashes meets the code requirements for minimum height or width and net clear opening for an emergency escape and rescue opening. The mullions between the swinging sashes and the fixed pane are not vertical load bearing. Can the window unit as a whole be considered in the 5.0 sq. ft. first floor and 5.7 sq. ft. upper story glass area requirement or does each swinging sash or fixed pane have to be considered separately?

Answer:
The window unit can be considered as meeting the 5.0/5.7 sq. ft. requirement if in the estimation of the local inspector the mullion between the swinging sash and the fixed pane can be knocked out with a fireman's ax with no more effort than would be required to knock out a sash of a double hung window.

This interpretation would also apply if the window were just two swinging sashes without a glass pane separating the two sashes.

Emergency escape and rescue windows
R310.2.1

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

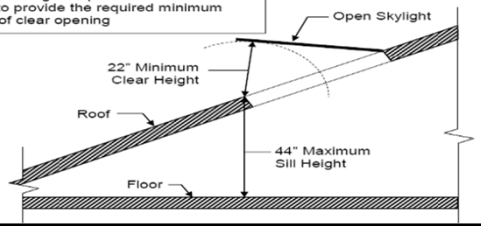
Skylights Used as Emergency Escape and Rescue Openings

Code: 2018 Residential Code **Date:** April 9, 2019
Section: R310

Question:
Can skylights that meet the requirements of Section R310 be used as emergency escape and rescue openings?

Answer:
Yes. The minimum opening height, width, and area must be available with the skylight in the open position (see sketch below).

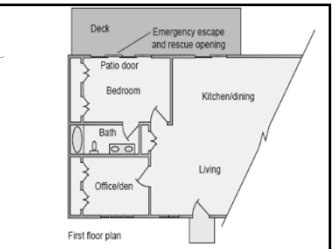
EXAMPLE of OPENING DIMENSIONING:
22" clear height requires a 37 ½" clear width to provide the required minimum 5.7 sf of clear opening

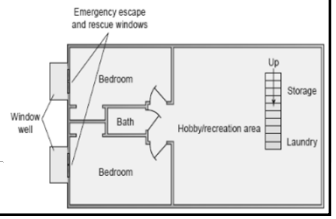


Emergency escape and rescue location
R310.2

Required in:

- Basements
- Every sleeping room.
- Habitable attics.



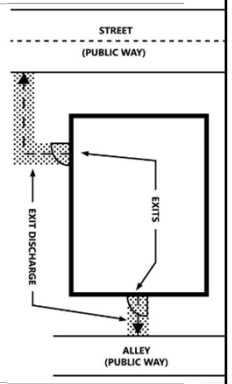


Emergency escape and rescue openings
R310.2.2, 310.2.5, R310.6

- Reorganized.
- New exceptions for basements.
- Window wells required.
- Doors 22" are allowed as em. egress.

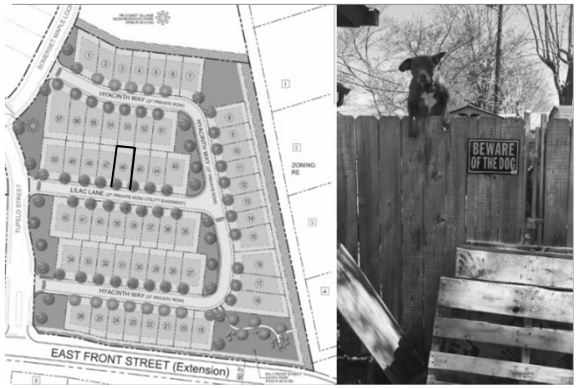
Public Way
R310

The required egress door shall open directly into a public way, yard or court that opens to the public way.



Public Way
R310

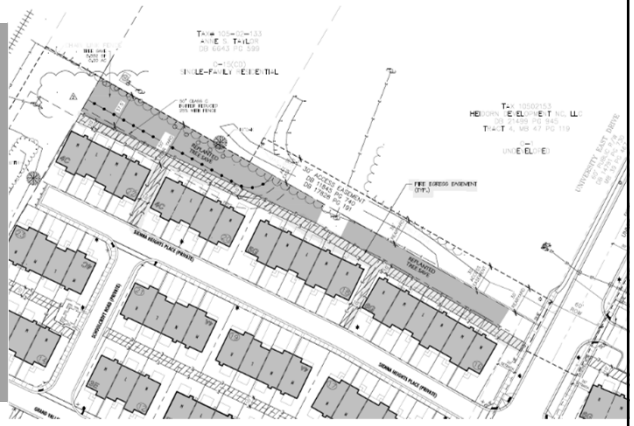
Townhome lots with no access to the public way through the backyard.



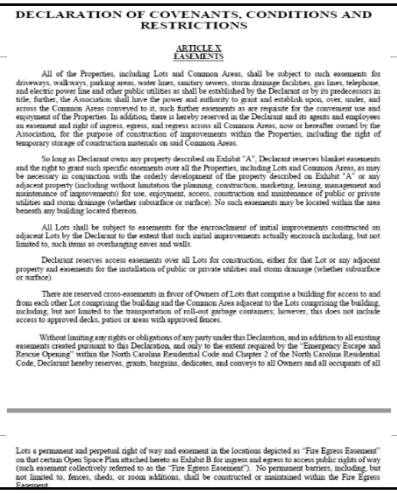
Public Way
R310

Egress may be guaranteed through an **Easement** or a **CCR** (Declaration of Covenants ,conditions and restrictions Agreement) in MCCE.

Egress easement



Declaration of Covenants, conditions and restrictions (CCR)



DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS

ARTICLE X
EASEMENTS

All of the Properties, including Lots and Common Areas, shall be subject to such easements for driveways, walkways, parking areas, water lines, sanitary sewers, storm drainage facilities, gas lines, telephone, and electric power line and other public utilities as shall be established by the Declarant or by its predecessors in title; further, the Association shall have the power and authority to grant and establish upon, over, under, and across the Common Areas conveyed to it, such further easements as are requisite for the convenient use and enjoyment of the Properties. In addition, there is hereby reserved in the Declarant and its agents and employees an easement and right of ingress, egress, and regress across all Common Areas, now or hereafter owned by the Association, for the purpose of construction of improvements within the Properties, including the right of temporary storage of construction materials on said Common Areas.

So long as Declarant owns any property described on Exhibit "A", Declarant reserves blanket easements and the right to grant such specific easements over all the Properties, including Lots and Common Areas, as may be necessary in conjunction with the orderly development of the property described on Exhibit "A" or any adjacent property (including without limitation the planning, construction, marketing, leasing, management and maintenance of improvements) for use, enjoyment, access, construction and maintenance of public or private utilities and storm drainage (whether subsurface or surface). No such easements may be located within the area beneath any building located thereon.

All Lots shall be subject to easements for the encroachment of initial improvements constructed on adjacent Lots by the Declarant to the extent that such initial improvements actually encroach including, but not limited to, such items as overhanging eaves and walls.

Declarant reserves access easements over all Lots for construction, either for that Lot or any adjacent property and easements for the installation of public or private utilities and storm drainage (whether subsurface or surface).

There are reserved cross-easements in favor of Owners of Lots that comprise a building for access to and from each other Lot comprising the building and the Common Area adjacent to the Lots comprising the building, including, but not limited to the transportation of roll-out garbage containers; however, this does not include access to approved decks, patios or areas with approved fences.

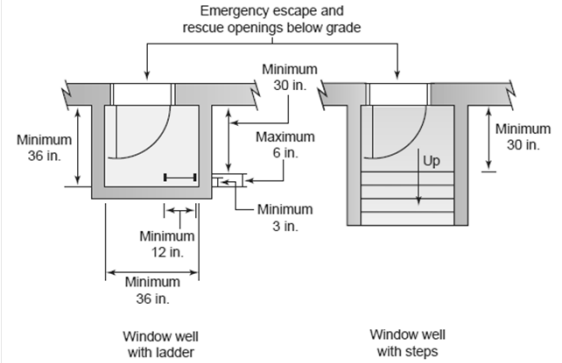
Without limiting any rights or obligations of any party under this Declaration, and in addition to all existing easements created pursuant to this Declaration, and only to the extent required by the "Emergency Escape and Rescue Opening" within the North Carolina Residential Code and Chapter 2 of the North Carolina Residential Code, Declarant hereby reserves, grants, bargains, dedicates, and conveys to all Owners and all occupants of all

Lots a permanent and perpetual right of way and easement in the locations depicted as "Fire Egress Easement" on that certain Open Space Plan attached hereto as Exhibit B for ingress and egress to access public rights of way (such easement collectively referred to as the "Fire Egress Easement"). No permanent barriers, including, but not limited to, fences, sheds, or room additions, shall be constructed or maintained within the Fire Egress Easement.

Window wells
R310.2.3

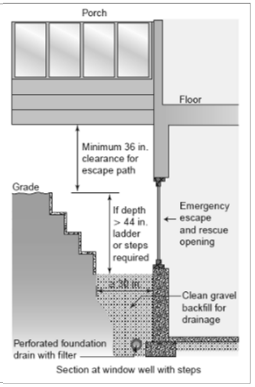
- Window wells must be at least **9 sf**. in area with a minimum dimension of **36".**
- The code requires a ladder or steps when the window well is greater than **44"** deep.

Window wells
R310.2.3



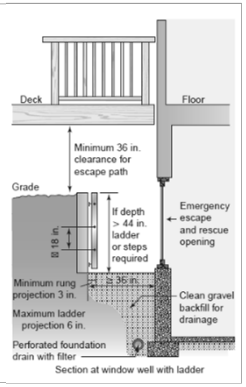
Window wells ladders
R310.2.3

- Window wells must be at least 9 sf with a minimum dimension of **36".**
- The code requires a ladder or steps when the window well is greater than **44"** deep.



Window wells ladders
R310.2.3

- A ladder or step is allowed to encroach into the required window well area no more than 6".
- A foundation drainage system is not required.



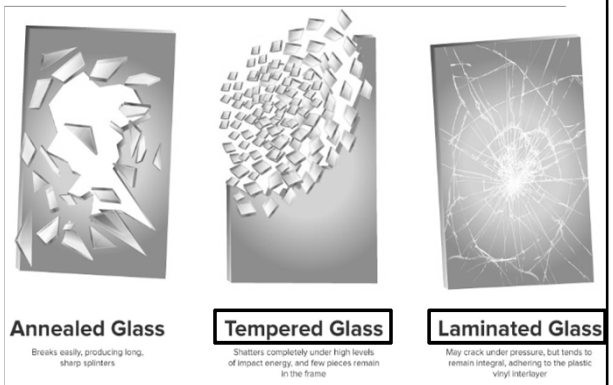
Safety Glazing

Glazing
R308

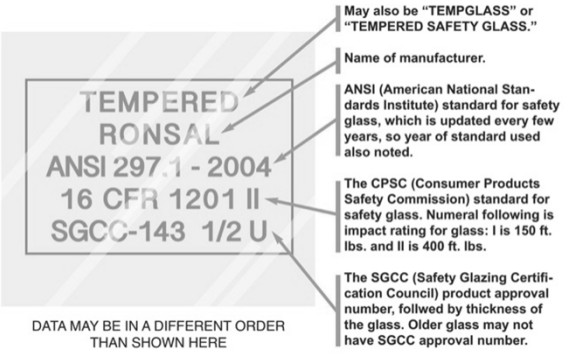
New!

- **R308** Reorganized
- **R308.4.4** Guards added
- **R308.4.5** 60" from water's edge. i.e. showers, hot tubs, saunas etc.
- **R308.4.6** Exterior doors with elevations < 8 ¼" do not require safety glass.

Types of safety glass
R308.4



Safety glass identification
R308.1



Identification alternatives
R308.1, exceptions

Other than tempered glass:
- Labels may be omitted where approved by the building official and an affidavit, certificate or other evidence is submitted indicating code compliance.

Tempered spandrel glass:
- A manufacturer can identify safety glazing with a removable paper designation, provided removal would destroy the designation. This ensures that the designation will not be applied to a noncomplying piece of glass.

Identification alternatives
R308.1, exceptions

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Glazing Labeling in Hazardous Locations

Code: 2018 NC Residential Code **Date:** March 22, 2019
Section: R308.1

Question:
Is Section R308.1 referring to the glazing or the label being destroyed when removed?

Answer:
It is referring to the label itself and not the glazing. According to the 2015 IRC commentary, "A manufacturer can identify safety glazing with a removable paper designation, provided removal would destroy the designation. This ensures that the designation will not be applied to a noncomplying piece of glass".

Multi-pane assemblies
R308.1.1

- Allows labeling of only one pane of glass when the exposed area of each pane is ≤1 sf.
- All other panes must be labeled either "16 CFR 1201" or "ANSI Z97.1

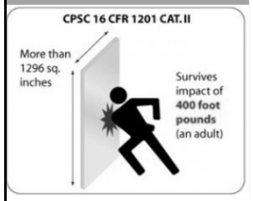
Impact load test required
R308.3

The code requires that glazing in **hazardous locations subject to human impact,** pass impact tests.

Exceptions:
1. Louvered windows and jalousies meeting the thickness and length limitations in Section R308.2.
2. Mirrors or glass hung on a wall or fitted with a backing.
3. Glass block constructed in accordance with Section R610.



Testing requirements
R308.3.1

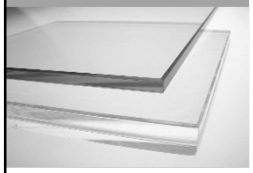


CPSC 16 - CFR 1201

- **Category II** required (unless otherwise indicated in Table 308.3.1). This is also a federal standard.

Exception:
Glazing NOT in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers may use **ANSI Z97.1.** and be **Class A** (unless indicated in table 308.3.1).

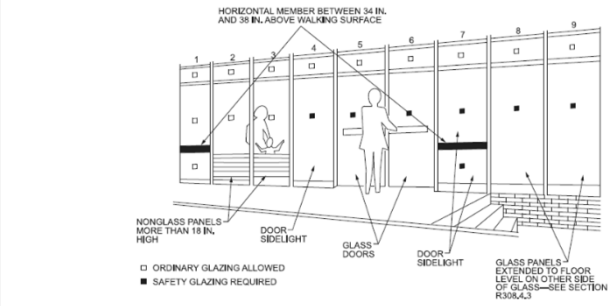
Safety glass
R308.4



The code identifies 7 locations that are hazardous to install safety glass.

1. In doors (fixed &operable)
2. Near doors
3. In windows
4. Guards and railings
5. Wet surfaces
6. Near stairs or ramps
7. Bottom of stair landings

Hazardous locations
R308.4.1



For SI: 1 inch = 25.4 mm.

Figure R308.4(1)
HAZARDOUS LOCATIONS

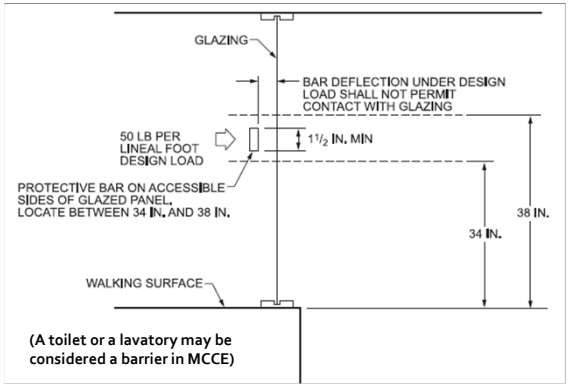
1. Doors
R308.4.1

Safety glazing is required in fixed and operable panels of swinging, sliding and bi-fold doors.

Exceptions:
- Glazed openings where a 3-in.-diameter sphere cannot pass through.
- Decorative glazing.

Barrier exception for windows

R308.4.3 , exception 2

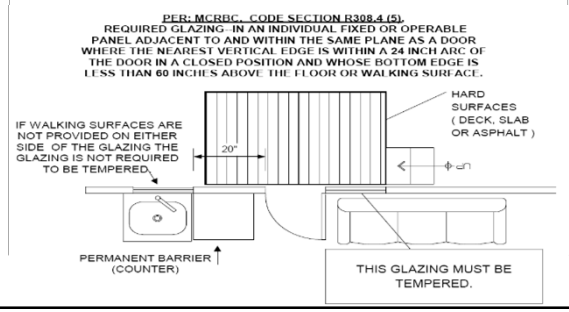


(A toilet or a lavatory may be considered a barrier in MCCE)

What is considered a walking surface?

R308.4.1

Any walking surface interior or exterior. The existence of a permanent barrier on one side of the window would not eliminate the need for tempered glass if the conditions on other side would still require tempered glass.



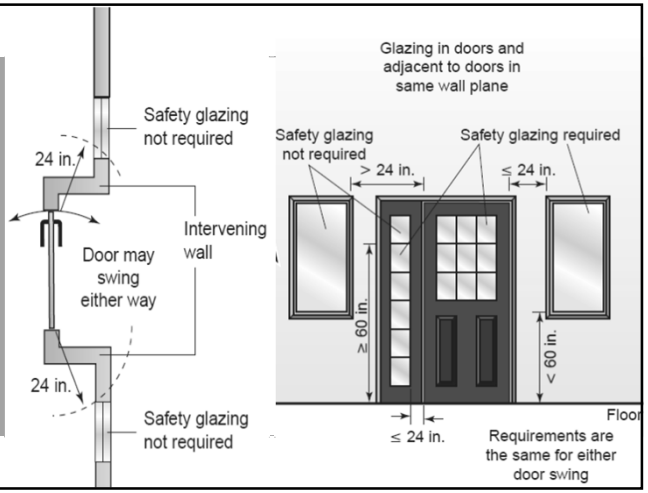
Barrier exception

R308.4.2 , exception 2

A lavatory counter can be considered a barrier in MCCE.

2.Near doors

R308.4.2



2.Near doors
R308.4.2

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Tempered Glass Next to Doors

Code: 2018 Residential Code **Date:** March 22, 2019
Section: R308.4.2

Question:
If a window is located within 24" of a door, is tempered glass required?

Answer:
Yes, if the glazing is in the same plane as the door and the bottom edge of the glazing is less than 60 inches above the floor.

No, if the glazing is not in the same plane as the door or the bottom edge of the glazing is 60 inches or more above the floor.

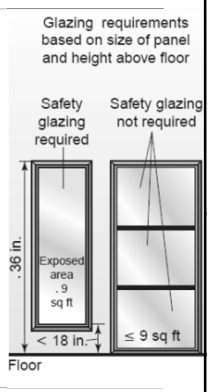
Exceptions near doors
R308.4.2

- Decorative glazing.
- Intervening wall or other permanent barrier between door and glazing.
- Access through door is to closet or storage area ≤ 3 ft. in depth.
- Glazing that is adjacent to the fixed panel of patio doors.

3. Windows
R308.4.3

All four stated conditions must occur before safety glazing is required:

1. The area of an individual pane must be more than 9 sf.
2. The bottom edge must be less than 18" above the floor.
3. The top edge must be more than 36" above the floor.
4. One or more walking surfaces must be within 36" measured horizontally from the glazed panel.



3. Windows
R308.4.3

NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

Tempered Glass for Windows 9 Square Feet or More

Code: 2018 Residential Code **Date:** March 22, 2019
Section: R308.4.3

Question:
If a window is 9 square feet or more, does it have to be tempered?

Answer:
Section R308.4.3 Glazing in windows. Glazing in an individual fixed or operable panel that meets **all** of the following conditions shall be considered to be a hazardous location:

1. The exposed area of a single pane is larger than 9 square feet,
2. The bottom edge of the glass is less than 18 inches above the floor,
3. The top edge of the glazing is more than 36 inches above the floor; and
4. One or more walking surfaces are within 36 inches, measured horizontally and in a straight line, of the glazing.

Exceptions:

1. Decorative glazing.
2. Where a horizontal rail is installed on the accessible side(s) of the glazing 34 to 38 inches above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot without contacting the glass and have a cross-sectional height of not less than 1-1/2 inches.
3. Outboard panes in insulating glass units and other multiple glazed panels where the bottom edge of the glass is 25 feet or more above grade, a roof, walking surfaces or other horizontal [within 45 degrees of horizontal] surface adjacent to the glass exterior.

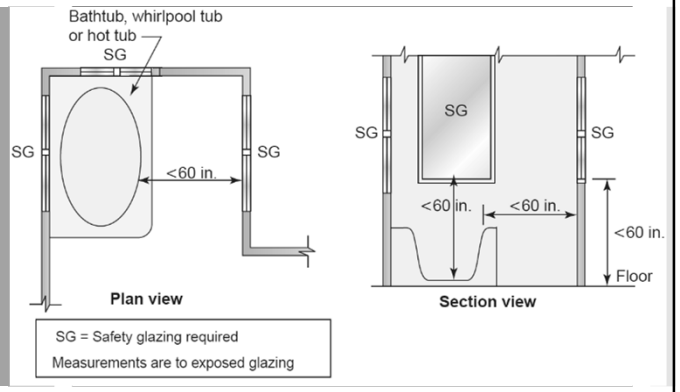
If any one of the 4 items in R308.4.3 are not met, then the window is not required to be tempered.

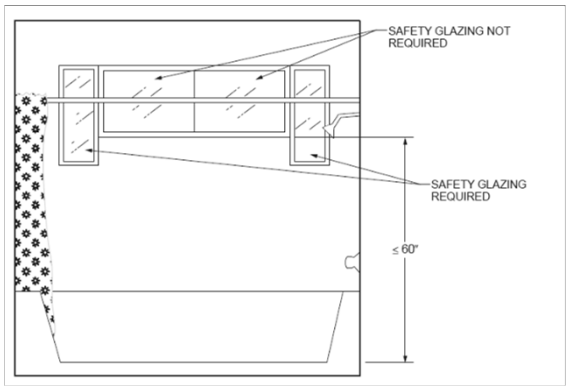
If either of the 3 exceptions in R308.4.3 are met then the glazing is not required to meet the safety glazing requirements of R308.4.3.

4. In guards and railings
R308.4.4

Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface shall be considered to be a hazardous location.

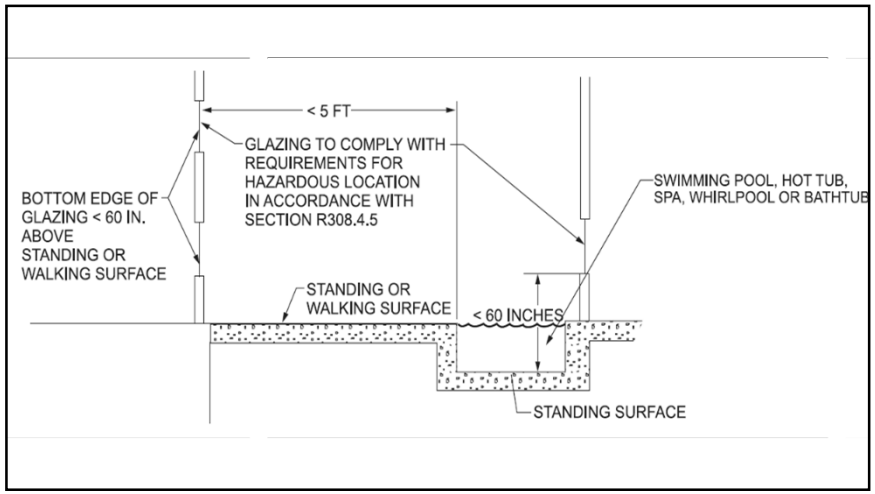
5. Wet surfaces
R308.4.5

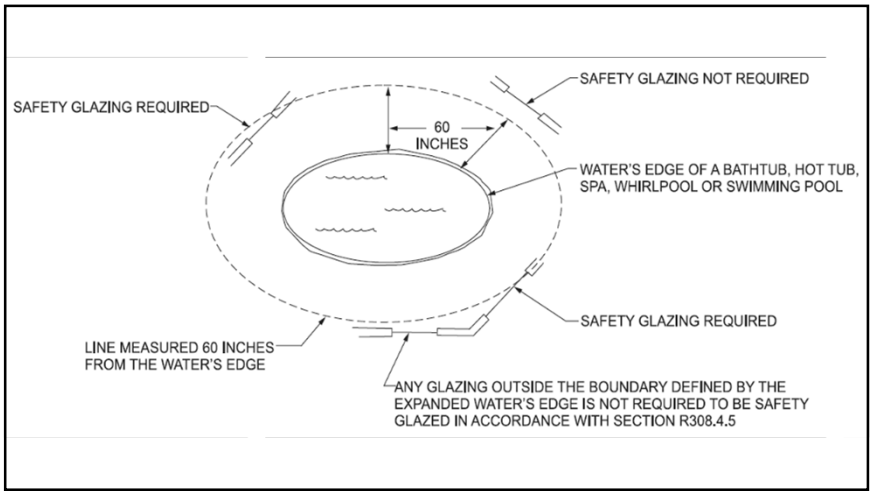




5. Wet surfaces
R308.4.5

Glazing in walls or fences near swimming pools
- ≤ 60 in. of water's edge
- < 60 in. above walking surface

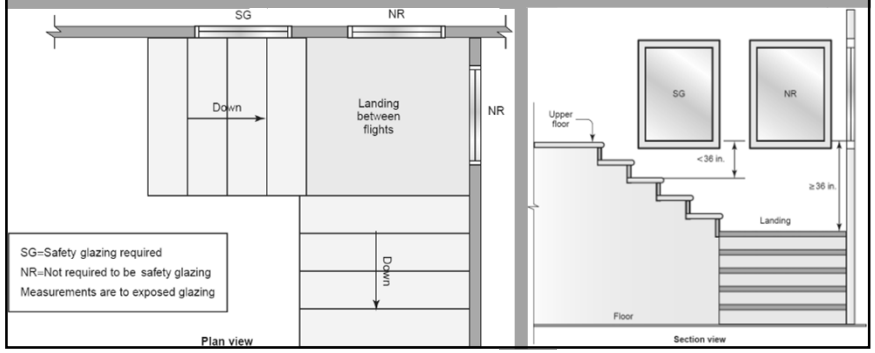




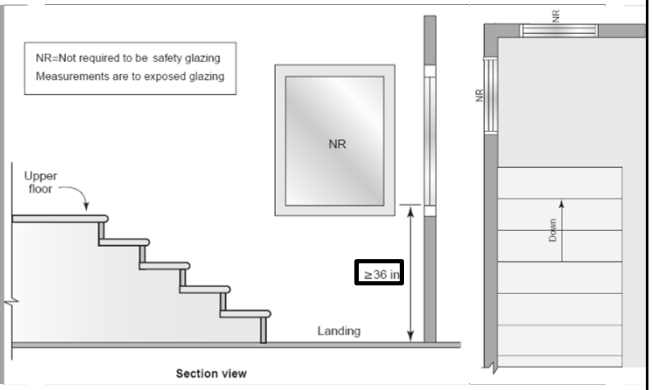
6. Near stairs or ramps

R308.4.6

Exceptions:
1. A rail is installed.
2. Glass is >36" a.f.f.
3. The exterior door elevation is ≤8 ¼"



7. At the bottom of stair landings R308.4.7



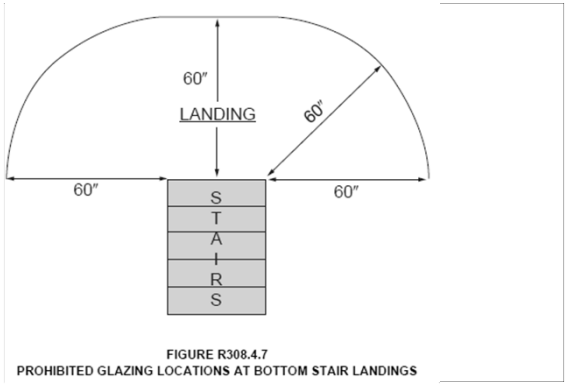
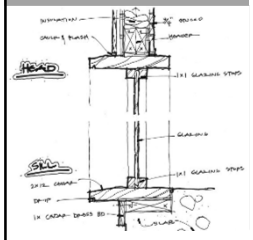


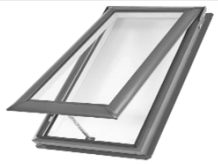
FIGURE R308.4.7
PROHIBITED GLAZING LOCATIONS AT BOTTOM STAIR LANDINGS

Site-built windows
R308.5



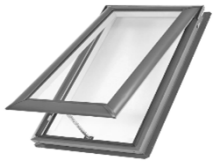
- Because site-built windows are not constructed in a manufacturing facility that follows industry standards, they must be constructed in accordance with Section2404 of the IBC.
- Section2404 sets the required wind, snow, seismic and dead loads on glass.

Skylight & slopped glazing
R308.6



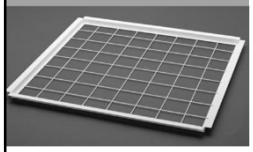
- Glazing installed in roofs or walls that are on a slope **15 degrees or more** from the vertical.
- The is to protect occupants from the possibility of falling glazing materials.

Skylights & slopped glazing materials
R308.6.2



- **Laminated glass**
  - 0.015" polyvinyl butyral interlayer
  - ≤16 sf. area
  - Highest point is at 12 ft. af.f. max.
- **Fully tempered glass** (with screen protection).
- **Heat-strengthened glass** (with screen protection below).
- **Wired glass.**
- **Approved rigid plastics.**

Safety Screens
R308.6.7



- Screens must support the weight of the glass.
- The screen and its fastenings must be capable of supporting twice the weight of the glazing.

Greenhouses
R308.6.6

- The glazing regulations for greenhouses are less stringent because greenhouses are seldom occupied during storms that might break the glass.
- Screens are not required for sloped areas of greenhouses if the ridge of the greenhouse is not more than 20 feet above grade.

Questions?

Q: How do we know which interpretations by DOI are formal and which ones are informal?

A: All interpretations posted on DOI are considered formal and shall be accepted by MCCE or any other jurisdiction. If an interpretation is deemed informal by DOI, it will be noted as such.

Next Meeting:

Code Connection - HBA July 3th

Please e-mail topics to:
eurilynn.caraballoluccioni@mecknc.gov

Thank you